CHEMICAL
& METALLURGICAL
ENGINEERING

How Shall the Government Nitrate Plants Be Operated?

IF THERE is serious and substantial opposition to the idea of the Government operating the nitrogen-fixation plants at Muscle Shoals, it has not been disclosed in organized form at the present writing. On the other hand, there is a growing sentiment in favor of the plan, seeing that two other nations, Germany and Chile, are officially engaged in the nitrogen industry and realize the importance of nitrogen in national welfare. If the United States is to enter these ranks, what shall be the business and commercial machinery for its accomplishment? Shall the War Department undertake the job on account of the close relation between nitrates and munitions? Or shall it fall to the lot of the Department of Agriculture in view of the peace-time importance of nitrogen for fertilizer? Or shall the Department of the Interior be the medium, on the score that nitrogen fixation is a conservation measure and is closely linked with the development of water power?

None of these queries brings an unqualified affirmative answer. And for reasons which we believe will be obvious. A better plan, in our judgment, is contained in the proposal to organize the United States Fixed Nitrogen Corporation, all the stock of which shall be owned by the United States and which shall be free to conduct its business without the restrictions and red tape incident to departmental operation. This corporation would have a working capital with which it must achieve success or failure, and it could not come hat in hand to Congress for annual appropriations with which to conduct its business. Once organized and financed, it would have to stand or fall by its results. It would be free to work like other corporations, and have similar responsibility to its single stockholder, the United States. It would conduct research simultaneously with the development and operation of its plants, and would keep pace with developments in the art of nitrogen fixation so that in emergency the Government would find itself fully informed and in possession of a trained personnel.

Bills proposing such a corporation have already been introduced in both houses of Congress, and hearings have been held by the Senate Committee on Agriculture and Forestry, to which the Senate bill was referred. The House bill has not yet been considered, but it is identical with that of the Senate. The Senate hearing, which is reported elsewhere in this issue, was unusually well organized. The Secretary of War appeared in favor of the bill, and made an exceptionally good statement, showing a grasp of the situation most commendable in a high official. He was supported by officers of the Nitrate Division of the Ordnance Department and by civilian chemists and engineers. There was little discussion of the detailed provisions of the bill itself, the evidence being confined mainly to the necessity of operating the plants and the benefits which would accrue to the country in such an event. Our own discussion of the bill will be reserved to a later date after further study.

In the meantime we favor the general plan as outlined, and expect to present more detailed statements explaining why a United States Fixed Nitrogen Corporation is apparently the best medium for Government operation of the plants at Muscle Shoals. Not the least impressive argument for the plan is the proposed method of financing the corporation without appropriating new funds, the necessary capital being found in the sale of a part of our reserve of Chilean nitrate, which could be safely reduced if the nitrate plants were in regular operation.

Is Pearlite a Special Form Of Widmanstättian Structure?

DR. GIOLITTI elaborates a hypothesis on the crystallography of ferrite which is very suggestive, and which he has found useful in his own practice for many years. For this reason, if for no other, it is undoubtedly worth the careful consideration of those familiar with the eminent Italian's ideas. Unquestionably they will think back over their own experience and justify it, or condemn it, as the majority of instances are marshalled on one side or the other.

Briefly, his idea is this: Many facts seem to indicate that the crystalline habit of beta iron is massive, that of alpha iron laminar. Given correct cooling conditions, then, a micrograph will show rounded particles of ferrite in low carbon iron, and thin striations in the higher carbon areas.

Some recently published illustrations bear out the theory quite strikingly. For instance FOLEY and later CLAYTON have published brief communications in the *Bulletin* of the American Institute of Mining and Metallurgical Engineers, showing pronounced Widmanstättian structure within the pearlite grains of low-carbon nickel-steel ingot runners. Such grains are notably higher in carbon within than at their surfaces, and doubtless the ferrite precipitated directly as alpha iron at temperatures below Ar_3, and, by this new hypothesis, should have a plate-like habit. Yet this structure in FOLEY'S metal, strangely enough, is confined to a thin shell immediately below the outer skin. Why should ferrite from one pearlite grain accumulate in parallel bandings, while that from a closely adjacent grain be finely divided, almost emulsified?

CLAYTON'S photographs are especially interesting in showing swirls of curved ferrite, which he ascribes to

the supposed influence of pre-existing rounded grains of austenite. Could they not more plausibly be regarded as the early stages of growth of a true pearlite grain, with its characteristic laminated structure?

Conceive an undercooled particle of austenite containing approximately eutectoid composition and a nucleus of ferrite to appear somewhere near its center. Reaction spreads outward from this germ with relatively high velocity as from a detonator, alternately producing shells of cementite and ferrite as the wave of transformation passes outward. The succeeding shells would become supersaturated with carbon and with iron alternately, and a characteristic onion-like structure results from the attempt to maintain equilibrium. It seems that a structure should be produced which is somewhat independent of the cleavages existing in the austenite, and might well appear exactly like the swirls photographed by CLAYTON, especially when reinforced by the plate-like crystalline habit postulated by GIOLITTI.

Such speculations as these are extremely attractive to the metallurgist of philosophical propensities, and are not without importance to the ultra-practical, since it is well known that Widmanstättian structure is an undesirable constituent in steels to be used under impact or alternating loads. Yet to know how to avoid it, it is best to know what it is.

Exit the National
Laboratory Foundation

PROBABLY few of our readers are familiar with the brief existence of a project known as the National Laboratory Foundation; and if we reverse the usual order by recording its demise without having first announced its birth, it is because we were skeptical of the proposition and preferred to watch its course before approving it. Always there was the feeling that a Senegambian was concealed somewhere in the proverbial woodpile. There was no lack of laudable purpose or commendable object, which was to provide laboratory facilities for invention and research, especially for those who had limited resources. But the original sponsors for the scheme—who were they? and what motives animated them? As far as we were aware none of them was known to science, but they were astute enough to gain for their scheme the tacit approval of famous and reputable men in various fields of scientific endeavor. That those men finally proved quite as astute in fathoming the unethical depths of the plan and refusing to further its success is much to their credit. Just what they discovered we do not know in detail, but doubtless they were led to wonder why a contract had been made with one individual for the payment of a commission on the collection of the proposed endowment. That they discovered evidence of an entangling alliance with the National Institute of Inventors and the National Inventors Sales Corporation, and "their personnel, policies and methods," is disclosed in resolutions condemning the plan and disavowing further responsibility for it. The National Laboratory Foundation was launched with much speaking and dining; it was wrecked on the rocks of personal advantage and private gain. Superficially it was a fine plan, but science and invention would have been scandalized by its success. There is still an opportunity for service by such an institution, but its sponsors, like CÆSAR'S wife, must be above suspicion.

Our Greatest
Chemical Industry

COAL utilization is undoubtedly the greatest chemical industry of this country; in fact, it is perhaps our greatest industry of any sort. It includes byproduct coking, locomotive- and stationary-boiler problems, the operation of city gas works, and a multitude of other forms of direct coal utilization in industries, as well as a vast number of byproduct problems of the widest possible interest. Just now there is a very striking development in this great industry that probably has been overlooked by most of our chemical interests. This relates to the city gas works or the coking of coal for municipal gas supply.

Recently two large gas companies have announced plans for installing coking plants for the production of coal gas which is to replace carbureted water gas; and this is only a beginning, with no end of the changes in sight. In 1915, for example, 550 plants produced 136 billion cubic feet of water gas. In more recent years the quantities produced have been even greater and a very large proportion of this water gas, which was made from coke or anthracite and gas oil, must be eliminated and coal gas or coke-oven gas made from bituminous coal substituted. This is essential because of the tremendous increase in the cost of all petroleum products which is making practically prohibitive the purchase of gas oil for water-gas manufacture.

The Washington Gas Light Company announced recently its plans to build a plant to produce 10,000,000 cu.ft. of coke-oven gas per day. The immediate cause of this change was the increase in the price of oil from $7\frac{1}{2}$ cents per gallon on recent contracts to over 12 cents a gallon for offerings now available; and there is some uncertainty whether sufficient quantity is available even at this higher price. Similarly, the Peoples' Gas Light & Coke Co. of Chicago has arranged to build a large coke-oven plant with a capacity of at least 12,000,000 cu.ft. of coke-oven gas per day. These are only two of the significant changes; many more are inevitable throughout the country unless unexpected reductions in the price of petroleum occur in the immediate future. In fact, we can expect that within a few years a hundred billion cubic feet of water gas will be replaced by coke-oven or coal gas.

The production of this gas from byproduct and retort processes will range from 5,000 to 10,000 cu.ft. of gas per ton of coal carbonized, averaging perhaps 7,000 ft. per ton, taking together all the processes that are likely to be used. On such a basis we can foresee the prospective use of 12,000,000 to 15,000,000 tons of coal for carbonization in these plants.

The byproduct production from this large tonnage will be a considerable factor in many industrial lines. There will be 8,000,000 to 10,000,000 tons of coke made, much of it suitable for metallurgical use, the rest probably going into the markets as a substitute for anthracite, especially in the Central and Western territory, where anthracite is now selling at prices much above those demanded a number of years ago.

If such a tonnage of coal is handled, the production of ammonium sulphate will be from 125,000 to 150,000 tons per year above the present production. This represents a very large percentage increase in our supply. But at present the fertilizer industry is finding it necessary to replace many of its organic nitrogen sources such as tankage, dried blood, fish scrap, etc.

by other nitrogen sources, since these organic ammoniates have reached prohibitive prices. Therefore we can confidently expect the fertilizer industry to absorb readily such portion of this sulphate as may be offered to it.

The same factors which have brought about this tendency to change from water gas to coal gas have, of course, resulted in shortage of motor fuels. Consequently the light oils that we can expect from the carbonization of increasing quantities of coal, amounting to perhaps 30,000,000 to 40,000,000 gal. a year, will very readily be absorbed in the motor fuel industry. As a matter of fact the quantity in prospect will probably not amount to more than a very few per cent of the total motor fuel demand of the country.

Tar production in any such quantities as will follow from great changes in coal-gas production will require rather new industrial chemical developments. Of course our extensive road-building program will afford a large demand for tar, but it is probable that much of the 100,000,000 gal. or more of this material will find its market as a substitute for fuel oil rather than directly in any of the chemical industries.

Although these estimates of byproduct production are based upon a rather extreme assumption of change in character of gas-making processes, and therefore cannot be expected to materialize except during a period of years, yet they represent a very real tendency in our economic system and any one who ignores the trend of these times is likely before long to become very much out of touch with our industrial situation.

The Annual Report
Of the Steel Corporation

THE annual report of the United States Steel Corporation, issued in the usual pamphlet form of about fifty pages, 9 x 11 in., in the past week, may be scanned or studied from various viewpoints. From the economic viewpoint an interesting fresh piece of information is that $52,000,000 was deducted from the profits of 1919 as allowance for the Federal taxes, against $274,000,000 for 1918, the decrease being due partly to the rates provided in the law of 1918 being higher for 1918 than for subsequent years, and partly to the total profits having been less. The earnings remaining for 1919, after payment of subsidiary company bond interest, amounted to $143,589,063, a fact known approximately in January, when the report for the fourth quarter was issued, while the tax information is entirely new, since the quarterly report for 1919 differed from those of the two years preceding in containing no statement of the tax allowance. The earnings of $143,589,063 compared with $199,350,680 for 1918, $295,292,180 for 1917 and $333,574,178 for 1916, the corporation's record year. Prior to the war, however, the record was about $160,000,000, made in both 1906 and 1907.

Thus it is seen, from the economic viewpoint, that the Federal income and excess-profits taxes do not bear heavily upon the steel industry, nor upon the consumers of steel, should it be held that the tax is, or should be, passed on to the buyer, for the $52,000,000 tax allowance for 1919, if allocated entirely to the 12,000,000 tons of steel products sold by the corporation, amounts to only $4.34 per ton, the ton which is used being chiefly the gross ton.

From the economic viewpoint there is another very interesting thing in the report. There was $87,091,515 of new construction in the year, and $48,793,661 of this was charged to property account, the remaining $38,-297,854 being charged to profits, before the earnings were arrived at. A portion of the latter amount, the exact sum not being stated, represented the cost of making useful for the production of peace material certain facilities the construction of which had been undertaken for war purposes, while the other part was charged off from income on account of the cost having been "extraordinary" because of the existence of "war conditions."

Specifically the report states that the cost of the construction "over what the estimated cost of constructing and installing would have been in the pre-war period was charged off to income." Before the war, which some economists insist has permanently lowered the value of the dollar very greatly, this certainly meaning that properties left intact should be valued in many more dollars than formerly, the Steel Corporation's property account stood at $1,600,000,000. The total expenditures on construction in 1919 amounted to $87,-000,000, between 5 and 6 per cent as much. Far from rating its old properties as worth more dollars, by reason of alleged changed conditions, the corporation is not content to charge to property account the entire amount of these relatively modest expenditures, made under what it calls "war conditions," though as a matter of fact the Armistice was signed before the year began.

From the financial viewpoint, one observes that the Steel Corporation, after making allowance for the Federal taxes and after the deductions from income just referred to, had earnings sufficient to take care of all charges and dividends and still leave a surplus of $26,159,781, this being done on an output which is stated to have been 74.5 per cent of capacity, when it has been commonly held in the steel industry that operation under 80 or 85 per cent of capacity is distinctly uneconomical. In the report the corporation renews its expression of confidence in the propriety of the Industrial Board steel prices of March 21, 1919, to which it still adheres. It has higher wages to pay now, as well as increased costs in other respects, but on the other hand it is assured of full operation as far as physical conditions permit, this providing a more economical operation as well as a larger number of tons upon which to make profits.

From the purely physical standpoint, it is interesting to note the statement that operations averaged 74.5 per cent of capacity, when the output of steel products, weighed in the form in which they were sold to outsiders, was 11,997,935 tons. Thus the corporation's estimate of its capacity is 16,200,000 tons per annum, or 52,500 tons per working day. The corporation's record output was in 1916, when physical conditions, while satisfactory for most of the year, distinctly limited output in the closing weeks, and in that year the output was 15,460,792 tons, equal to precisely 50,000 tons per working day. Mill outputs usually increase from time to time even without definite improvements, while there have been some new installations. Thus the present estimate of 52,500 tons as capacity is obviously conservative, and is likely to be exceeded in the near future, as transportation conditions, the only important barrier to full operation, are improved.

Readers' Views and Comments

Atomic Structure of Metals in Solid Solution

To the Editor of Chemical & Metallurgical Engineering

SIR:—There has been recently some discussion in your columns of an article of mine on the atomic structure of metals in solid solution (CHEM. & MET. ENG., vol. 21, pp. 566-70).

Dr. Jeffries (CHEM. & MET. ENG., vol. 22, p. 100) does not take up the important aspect of the paper, i. e., the agreement between the observed values for the maximum electrical resistance of the binary alloys Ag-Au, Au-Cu, and Cu-Ni, and the values calculated by means of the theory advanced. He makes the suggestion that an alloy of equi-atomic percentages of Ag and Au might be expected to show a sharp break in resistance at the melting range, but he quotes no experimental evidence in its support. So far as I was able to inform myself, there is no datum on this point, either for Ag-Au or any other binary solid solution alloy immediately above the liquidus and immediately below the solidus. Naturally, measurements made on such a system in the melting range where two phases, liquid and solid, are present, would have no definite physical significance.

It is of interest, however, to call attention here to the fact that Northrup (*J. Franklin Inst.*, vol. 182, pp. 477-509) has measured the resistance for the eutectiferous system Sn-Bi and finds for the eutectic composition (58 atomic per cent Sn) no appreciable break in the temperature-resistance curve at the melting point, but simply a point of inflection. Dr. Jeffries' suggestion might be interpreted as applying here with equal force, but the experimental evidence disproves its validity. I can see nothing, other than a direct measurement, which can discredit the assumption that the temperature-resistance curves for binary solid solution alloys, in both the liquid and solid "amorphous state," lie along the same smooth curve.

As an argument against the tenableness of my theory Dr. Jeffries has drawn attention to the existence of heats of crystallization and of fusion in the case of the alloys in question. I would be interested to be referred to such measurements as these in the literature. I admit that cooling curves show the existence of a definite point of inflection at the liquidus, and of a very ill-defined point at the solidus. But these data have not yet been interpreted to give any quantitative idea of the quantities of heat involved in solidification. There are other processes operating in the melting range, particularly the well-known diffusion phenomena, which might be involved in the observed heat effects but which are distinct from the true heat effects of fusion and crystallization.

It was not argued that in passing through the melting range there does not occur a change from the liquid to the solid state, a process involving as its most noticeable accompaniment a change in viscosity. No one has yet claimed any direct relation between viscosity and the existence or non-existence of the crystalline state. Consider, for instance, the substances described as liquid crystals.

The electrical data establish with a degree of certainty, based on an unusual quantitative agreement between the theoretical and observed values of elec-

trical resistance, that the binary solid solution alloys of maximum resistance have a structure in the solid state identical with that of the liquid state so far as metallic conduction is concerned. Now, there are few, if any, properties which are so intimately dependent upon the atomic structure of an alloy as is its electrical resistance. Electron distribution determines largely the atomic combinations, and it is a most important factor in determining the electrical resistance.

We are now brought to an important point of Dr. Jeffries' criticism, and one which was also discussed more fully in Dr. Donald P. Smith's (CHEM. & MET. ENG., vol. 22, p. 340) more recent, excellent comment on the subject of my paper—namely, the existence even in the solid solution alloys of maximum resistance (approximately equi-atomic proportions) of what appears to be a crystalline structure, when examined microscopically as a polished and etched specimen. I take it to be understood that the existence of a "granular" or non-homogeneous structure obtained by an examination of alloys which have been more or less rapidly cooled through the melting interval, and which show the "cores" and dendritic formations caused by the inherent nature of the freezing of solid solution alloys (i. e., difference in composition between liquid and deposited solid at all points other than at a maximum or minimum on the freezing curve) has no bearing upon the present discussion. Homogeneity of structure, obtained by thermal treatment, is a first consideration. I am unwilling to admit that in the case of such a homogeneous structure the appearance of what are called "grains" by the metallographist is conclusive evidence of the existence of a crystalline structure, in the true meaning of the word. I can conceive of the existence of a granular structure in a perfectly amorphous solid.

It might be well to call attention to the fact that it has been quite customary to attribute a definite melting point to a crystal, to distinguish it from a mixture. However, a binary solid solution crystal, if such, perchance, exists at equi-atomic concentrations, does not melt at a constant temperature. Hence, the "crystalline" structure of solid solution alloys must be of a different type from that of ordinary crystals, and the crystallization phenomena at the melting range must be correspondingly modified. According to my theory, based on an independent quantitative relation which exists regardless of the validity of the theory, crystallization in binary solid solution alloys of maximum resistance is modified to such an extent that the atomic structure of the solid alloy is identical with that of the liquid. If it is conclusively shown that the solid alloys are crystalline, then I will modify my theory to the extent of assuming that the same type of crystalline structure exists in the liquid alloys.

I do not fully understand the significance of Dr. Jeffries' reference to "the directional and deformational characteristics of solid solution alloys." The components of the systems studied belong to the cubic system. Hence the only directional characteristic to be expected is that of the three crystalline axes, determinable only in the case of idiomorphic crystals. Since we are not dealing with idiomorphic crystals, and I do not believe they have been observed in the cases under consider-

tion, I am unwilling to admit without further evidence that slip-bands are dependent upon or are determined by cleavage planes corresponding to the existing direction of these axes. Cleavage planes are found in some amorphous bodies.

According to recent investigations of Tammann (*Nachr. Kgl. Ges. Göttingen*, 1916, pp. 199-265; 1917, pp. 345-72, 385-425), the difference between a "mixed crystal" and a chemical compound depends upon the electrons surrounding the positive core. For solid alloys of the systems Ag-Au and Cu-Au it was found that the atoms were present in the free state, while Au-Zn alloys form a compound in equi-atomic proportions. These conclusions were reached from experiments on galvanic potential. Moreover, certain well-defined limits of resistance to galvanic attack were found, with respect to the composition, of such solid solution alloys as Au-Ag and Au-Cu. There may well be a certain relation between these observations and the formation of an increasing amount of solid amorphous metal with increase of concentration.

I wish finally to call attention to a misprint in Dr. Smith's discussion. In the first paragraph, Ag-Cu should read Au-Cu.   ALEX. L. FEILD.

Niagara Falls, N. Y.

The Technical Engineer's Judgment of the Oxy-Acetylene Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—The writer is interested to note the article in your issue of Feb. 4, 1920, entitled "The Technical Engineer's Judgment of the Oxy-Acetylene Process," by Alfred S. Kinsey. In the paragraph on "Forge Welding," Mr. Kinsey states:

"Up to the advent of autogenous welding the engineer had only his experience with the forge weld upon which to base his calculations and judgment. In a way this proved somewhat unfortunate for the new method of welding, as the forge weld has nearly lost its value as a dependable means of joining metals. Imagine two pieces of steel being brought to a soft plastic condition in a forge fire charged with sulphur from the fuel, an excess of oxygen from the indifferently operated bellows or fan blower, the cinders and refuse of the fuel, and one can readily realize the cause of weak forge welds. Such welds never were reckoned to have a tensile efficiency of more than about 50 per cent, and many observations of welds which had failed showed crystallization and even entrapped cinders. Navy yards and many other large shops had practically abandoned the forge weld, preferring the expensive substitute of machining a job out of the solid when it was possible to do so. Serious failures of forge welds were too common."

Mr. Kinsey is absolutely correct in his judgment of a forge weld as made by the process which he so aptly describes, but he seems to lose entire account of the fact that other processes of forge-welding, with improved methods of heating, have been developed since the days of the prehistoric blacksmith, which eliminate the very causes which he speaks of as being detrimental to a good weld—such as sulphur from the fuel, cinders and refuse, excess of oxygen by the blower, etc.

There are several advantages in joining metal together in its "plastic" condition which are completely overlooked by Mr. Kinsey in his article—such as the fact that the metal is not heated up to the point where it will absorb either oxygen from the air or carbon from the acetylene arc, as is the case from the carbide flame; that its chemical characteristics after being welded are not materially changed; and the vigorous working which it gets, which actually reduces areas and thereby distinctly changes the granular construction, greatly assists in the welding of the two pieces together under a hammer.

The advent of modern apparatus for heating the plates under an absolutely controlled condition of temperature, and the working under heavy, high-power-driven hammers, thus assuring a complete working of the metal and the breakdown of the crystalline structure, have made it possible to make forge welds whose efficiency and general dependability are far above any that can be made by the oxy-acetylene or any other known process. The range of thickness encompassed by the autogenous-welding process is extremely limited, whereas the forge-welding as done by modern apparatus is applicable to very heavy plates, and has been used successfully under pressures and temperatures far above any that have ever been attempted for autogenous-welded receptacles.

When the autogenous-welding process can be developed up to the point where it can make a cylinder, for example, 5 in. in diameter, of $1\frac{1}{2}$-in. plate, to stand a working pressure of 500 lb. and a temperature of 900 deg. F., and prove absolutely dependable for such service, it will then be safe to say that it has reached the point where it is as dependable as forge-welding by modern processes.

The old-fashioned forge weld as described in Mr. Kinsey's article is acknowledged to be just as unreliable as the autogenous weld made under relatively the same unfavorable conditions, and a long series of experiments and a thorough training in technique have been necessary to develop either of them to the point where they are today.   F. E. JOHNSON, JR.,

The M. W. Kellogg Co.,   Vice-President.
New York City.

Distribution of Apparatus and Reagents for Laboratory Courses

Prof. W. L. Estabrooke, of the department of chemistry of the College of the City of New York, described in a late number of *Science* the operation of the Freas system in distributing apparatus and reagents in a general chemistry laboratory. By this plan each student receives on his first day all the apparatus and chemicals he will need for the course and he is given just enough of each chemical to perform his experiments plus a slight excess. Should he be careless and need more he must go to the storeroom and sign for his needs, which are charged up to his breakage and "excess chemicals" deposit.

The prices on his list are the same as those charged at the nearest apparatus house, so he has no temptation to take things home. And it provides a great inducement for clean and orderly work, as well as effecting a great saving in chemicals.

It also increases the amount of work done in the given time during the course, compared with the still common, old side-shelf reagent system. In one laboratory Prof. Estabrooke computed that a student was likely to walk from thirteen to twenty-six miles during one term to go from his bench to the side shelf and back to procure needed chemicals.

Senate Hearings on U. S. Fixed Nitrogen Corporation Bill

HEARINGS on the bill to establish the United States Fixed Nitrogen Corporation were begun before the Senate Committee on Agriculture and Forestry Monday morning, March 22. This is a bill authorizing the Secretary of War to designate five persons for the purpose of organizing a corporation "to purchase, acquire, operate and develop . . . United States nitrate fixation plants numbered 1 and 2, located, respectively, at Sheffield, Ala., and Muscle Shoals, Ala." All of the capital stock of the corporation is to be owned by the United States, the common stock being issued for the properties acquired from the United States, and the preferred stock for the sum of $12,500,000 with which to complete and operate the plants and develop the art of nitrogen fixation. The plan was proposed to the Secretary of War by Arthur Glasgow, who made recommendations regarding the utilization of our nitrate plants, on the return of our military and agricultural commissions from Europe last fall. The object is to maintain the plants in peace-time operation for the production of nitrogen fertilizer compounds, and at the same time enhance their military value through the experience gained in operation and in contemporaneous research in the science and art of nitrogen fixation.

Secretary Baker was the first witness before the committee. He stated that three plans were open to the Government in disposing of the plants: First, to scrap them and secure what salvage value they represent, which would be admittedly low; second, to keep them in stand-by condition for the use of the War Department in emergency; or third, to operate them on a peace-time basis for the production of nitrogen fertilizer compounds. He showed that the pre-war requirements of the United States in Chilean nitrate amounted to 500,000 tons per annum, and that with the plants producing ammonium sulphate and other nitrogen compounds at their full capacity we would still have to import from Chile. Being questioned as to the proposed products of the plants, the Secretary stated that these probably would be ammonium sulphate, ammonium nitrate, calcium cyanamide and possibly ammonium phosphate. He said he was not converted to the extensive use of cyanamide as a fertilizer and would not like to see the plant make this as its only product. For this reason it would be necessary to add equipment for the manufacture of other nitrogen compounds.

PLAN FOR SECURING NECESSARY FUNDS

The most important development in the Secretary's testimony was the proposal, originally suggested by Colonel Burns, that the $12,500,000 necessary for financing the proposed corporation be obtained from the sale of half of the present reserve stock of Chilean nitrate now held by the War Department. The safe reserve of nitrate which it is considered necessary to carry in this country is 300,000 tons, and the War Department has now sold from its supply down to that figure. With the nitrate plants in operation, however, it would be safe to reduce this reserve to one-half, or 150,000 tons, and the sale of that quantity at present prices would provide the money for financing the new corporation. This would make it unnecessary for Congress to appropriate new funds for this purpose, as proposed in the original draft of the bill. The Secretary, therefore, suggested to the committee an amendment striking out the appropriation clause and substituting authorization to sell 150,000 tons of Chilean nitrate from the present reserve stock and subscribe the proceeds to the capital stock of the corporation. This is evidently regarded as a strong point in favor of the general plan, because it will forestall objections against new appropriations of public funds.

Additional advantages to be gained from the sale of a part of the reserve stock of nitrate were presented by General Williams and Colonel Burns. It appears that part of the reserve is carried in Government storage warehouses at interior points and part in commercial warehouses at the seaboard. The latter must eventually be transported to interior points and new warehouses must be constructed for its storage. General Williams stated that the sale of 150,000 tons of the reserve would obviate the expenditure of about $1,800,000 in new construction and freight. Colonel Burns stated that the cost of storage of 150,000 tons of nitrate for six months, partly in Government and partly in commercial warehouses, would cost over $100,000, all of which would be saved if the nitrate were sold.

The Secretary stated that one important reason why the Government should plan to operate these plants is that the whole question of nitrogen fixation is in a state of flux and that a vast amount of development and research work must be prosecuted before we know what products are best for various fertilizer purposes. He felt that the Government, which has no private interests to advance or special products to promote, could operate the plants and conduct research in such a disinterested way as to be of the greatest benefit to the country.

PLANS PRESENTED BY GENERAL WILLIAMS, COLONEL BURNS AND PROF. WHITE

General C. C. Williams, Chief of Ordnance, reviewed for the committee the general pre-war situation in this country regarding nitrogen compounds, and followed that with a brief history of the development of nitrate plants. Plant No. 1, using the synthetic ammonia process, was experimental and was not in successful operation at the time of the armistice. Plant No. 2, using the cyanamide process, was practically completed at armistice, and had been built because it was based on a proved process in which American engineers had had experience. The cyanide plant at Saltville, Va., was built to make cyanide for poison gas, but was experimental, and the process proved too costly as a method of fixing nitrogen for commercial purposes. In summarizing the present situation, General Williams suggested a program as follows: Proceed with development and research in the art of nitrogen fixation; make No. 1 Plant effective through such research and development; operate No. 2 Plant with the production of appropriate nitrogen compounds; and complete the Wilson dam at Muscle Shoals for the production of the necessary electric power.

Colonel Burns reviewed for the committee the history of the use of nitrates in military operations, and pointed out the need of nitrates in the manufacture of explosives, fertilizers and chemicals. His written statement will be printed in the record.

Methods of nitrogen fixation were outlined by Prof.

Alfred H. White, formerly an officer in the Ordnance Department. Eliminating the arc process as one requiring tremendous quantities of cheap power, the two processes which have gained commercial importance are the cyanamide and synthetic ammonia. These two processes were briefly described, and the technical difficulties of the synthetic process were compared with the simplicity and high degree of perfection of the cyanamide process.

DATA PRESENTED BY PROF. WHITE

Prof. White presented many interesting charts and figures showing the world's production of inorganic nitrogen, growth in fixation of inorganic nitrogen, and future development of nitrogen fixation in the United States. Tables I and II contain the essential facts.

TABLE I. WORLD'S PRODUCTION OF FIXED INORGANIC NITROGEN EXPRESSED IN METRIC TONS OF NITROGEN

	1908	1913	1917	1920
Chilean nitrate	300,000	390,000	392,000	500,000
Byproduct ammonia	212,000	343,000	364,000	410,000
Atmospheric nitrogen				
Cyanamide process	2,500	60,000	200,000	325,000
Arc and miscellaneous process	3,000	18,000	30,000	32,500
Haber process	......	7,000	110,000	308,000

TABLE II. WORLD'S PRODUCTION OF ATMOSPHERIC FIXED NITROGEN IN METRIC TONS OF NITROGEN

	1909	1913	1917	1920*
Arc and miscellaneous process	3,000	18,000	30,000	33,600
Cyanamide process	2,500	60,000	200,000	325,000
Haber process	......	7,000	110,000	308,000
	5,500	85,000	340,000	666,600

* Estimated maximum in possible production.

Other interesting data presented by Prof. White dealt with the domestic sources of fixed nitrogen in the various countries compared with the population. The United States is near the bottom of the list, coming ahead of only Italy and Austria. The following figures express tons of nitrogen per million of population: Germany, 8,760; Norway and Sweden, 7,250; Great Britain, 2,240; Canada, 2,200; France, 1,850; Switzerland, 1,840; United States, 1,480; Austria, 630, and Italy, 630. In closing, Prof. White stated that the field for nitrogen fixation in the United States was clearly one for Government operation if there ever was one, for both Germany and Chile are in the business on that basis and will struggle to dominate the world's supply of nitrates. The field is not an attractive one for private capital.

REPORT OF COLONEL JOYES

Colonel J. W. Joyes of the Ordnance Department, who made a trip to Europe as chairman and member of the U. S. Fixed Nitrogen Commission, made a report of some of his observations and studies in foreign countries, particularly in occupied German territory. Germany has a present capacity for fixing nitrogen of about 300,000 tons by the Haber process, 120,000 by the cyanamide and 150,000 by coke ovens and gas works. He gave figures (Table III) on capacity in different countries probably available for commercial production of fixed nitrogen.

Colonel Joyes stated that inspection of Germany's Haber plant at Oppau indicated great need of further improvement for satisfactory operation. He was impressed with the fact that labor and supervision forces must be quite large, although the expense for these items had not been large due to the low wages

paid up to 1914. It has been stated that ammonia was made in this plant for four cents per pound in 1914-15, but Colonel Joyes was convinced that present costs would be at least two and one-half times as much.

TABLE III. PROBABLE COMMERCIAL PRODUCTIVE CAPACITY OF WORLD NATIONS OF FIXED NITROGEN IN METRIC TONS OF NITROGEN

	Haber	Cyanamide	Arc	Total
Germany	300,000	93,000	......	393,000
France	......	40,000	1,000	41,000
Italy	......	12,000	1,000	13,000
Scandinavia	......	28,000	30,000	58,000
Austria	......	22,000	......	22,000
Switzerland	......	7,500	......	7,500
Japan	......	12,000	......	12,000
Canada	......	12,000	......	12,000
U. S. (Plant No. 2)	......	40,000	......	40,000
Total	300,000	266,500	32,000	598,500

Assuming the same plant set down in the United States in a favorable location, cost of production of ammonia under present price conditions would be approximately:

	Cost of Ammonia		
	Short Ton	Pound	
Operation and upkeep	$209 to $163	$0.105 to $0.082	
Amortization	75	50	.038	.025
Interest	45	45	.022	.022
Sales	2	1	......	......
	$331 to $259	$0.165 to $0.129	

Interest is figured at 6 per cent on $750, which is the assumed per-ton cost of the plant. Upkeep is taken at 10 per cent and amortization at 10 per cent.

The organization of the German Stickstoff Syndikat, or nitrogen syndicate, and the method of government operation and control, was described in some detail by Colonel Joyes. The capital stock of this syndicate is held by three different groups of industrial companies, each of which has a member on the board of directors, the government having the fourth. There will also be a board of managers, the chairman of which will be appointed by the government. The management will determine the production of various nitrogen compounds and their distribution.

STATEMENT OF COLONEL LAMB

Colonel A. B. Lamb, late of the Ordnance Department and now in charge of the Nitrate Division's research laboratory at American University, Washington, made a statement in which he stressed the necessity of continuing research in the art of nitrogen fixation. Starting with the assumption that the United States must meet foreign competition in nitrogen fixation as a matter of national welfare and safety, if for no other reason, he outlined briefly the different possibilities in producing nitrogen-bearing compounds such as ammonium sulphate, ammonium chloride, urea, ammonium phosphate, etc. The location of the Muscle Shoals plants near deposits of phosphate rock and potash-bearing minerals and a source of cheap water power afforded an opportunity to develop new fertilizer materials in addition to nitrogen. Research has been the fundamental factor in industrial development in Germany and elsewhere and must be continued in this country. It is not enough to know what the Germans or any other people are doing, or what their formulas and methods are; that is only part of the story, to be supplemented with local experience and the training of skilled operatives.

STATEMENTS BY MAJOR GAILLARD AND OTHERS

A statement by Major D. P. Gaillard, Ordnance Department, covered the demand and supply of inor-

ganic nitrogen in the United States, and the necessity for fixing atmospheric nitrogen. He showed that the diversion of the organic ammoniates, such as cotton-seed meal and tankage, from use in fertilizer to feed for animals, was taking that source of nitrogen away from the fertilizer industry. His statement was supplemented by instructive charts and figures. His estimate of the domestic peace-time consumption of inorganic nitrogen in 1924 was 294,500 tons, with an estimated domestic supply of 122,500 tons, leaving a deficiency of 172,000 tons. By 1930 the consumption is estimated to be 438,000 tons with a supply of 184,500, leaving a deficiency of 353,500 tons. If the Government nitrate plants are put in operation and produce 45,000 tons of nitrogen in 1924 and 55,000 tons by 1930, there will still be deficiencies of 127,000 and 198,500 tons respectively.

In addition to the foregoing testimony the printed record of the hearings probably will contain a statement by George J. Roberts on the estimated cost of operation at Muscle Shoals and a justification of the capital requirement of $12,500,000 requested in the bill. The recommendations of Mr. Glasgow mentioned in the beginning of this report will also be included.

Engineering Advertisers' Association

At the meeting of the Engineering Advertisers' Association of Chicago held March 9 at the Auditorium Hotel, the following officers were elected for the ensuing year: President, A. H. Hopkins, adv. mgr., C. F. Pease Co.; vice-president, J. J. Arnsfield, adv. mgr., Fairbanks-Morse Co.; secretary, G. S. Hamilton, adv. mgr., American Steam Conveyor Corp.; treasurer, E. I. Pratt, adv. mgr., Kellogg Switchboard & Supply Co.

Increased production is the topic of the hour and the Engineering Advertisers' Association in its efforts to improve the methods of advertising and selling engineering products will accomplish an object worthy of attainment and vital to every one. The present membership of the association is one hundred. Any man engaged in advertising or selling engineering products is eligible to membership.

President-elect Hopkins earnestly suggested that the members continue the splendid co-operative spirit that has marked the first year of the Association and emphasized the importance of the work to be done.

Immigration Conference

A national immigration conference will be held April 7 in New York City in the Engineering Societies Building, 29 West 39th St. National leaders in American industry and finance will discuss the shortage of foreign-born labor and the loss of production due to unrest among the workers, and measures will be taken for united action to relieve this condition.

Invitations to attend this conference have been issued by the Inter-racial Council to more than a thousand of the directors of industrial concerns, especially those employing foreign-born labor, and to others interested in this problem from the standpoint of finance or national welfare, including racial leaders. Topics to be discussed will include pending bills on immigration, and a constructive policy will be proposed and voted upon. All industrial executives are invited to be present. Further details may be secured by addressing Coleman du Pont, chairman of the board, the Inter-racial Council, 120 Broadway, New York City.

Further Changes Proposed in Dye Bill

AN AMENDMENT which removes the embargo clause in the dye bill has been introduced by Senator Moses of New Hampshire. It is known that the amendment has many friends among Senators.

ADDITIONAL DUTIES INSTEAD OF EMBARGO

Practically the whole of the bill, with the exception of section 500 (which enumerates the commodities in the three groups and their respective duties), has been revised. Instead of prohibiting the importation of articles in groups II and III, the amendment permits their entry, but on such articles as are being manufactured and offered for sale on a substantial scale in the United States another duty must be paid in addition to the duties provided for in section 500. This additional duty is equal to the difference between (1) the sum of the dutiable value of the article plus all non-dutiable costs, charges and expenses incident to importation, and any duty imposed by section 500, and (2) the fair wholesale selling price in the United States of a like article or satisfactory substitute of domestic manufacture plus 20 per cent of this price. In connection with this section:

> The term "fair wholesale selling price" of an article means the lowest wholesale price sufficient to insure the maintenance in the United States of the production of such article by an efficient plant operating on a scale reasonably adequate to supply ordinary domestic demands; and the term "satisfactory substitute" means an article capable of giving results in use substantially equal to the article for which it is proposed as substitute. The Secretary of the Treasury shall from time to time determine what is such "fair wholesale selling price" and such "satisfactory substitute."

TARIFF COMMISSION TO PROTECT AMERICAN INDUSTRY

Whenever the Tariff Commission, after proper investigation, decides that any article in this act is being imported under conditions which constitute a menace to the industry in this country, the Secretary of the Treasury will be notified and importation of the product will be prohibited until further notice from the Tariff Commission.

Whenever the Tariff Commission has reason to believe that a person is offering for importation any products in violation of this section, but has not information sufficient to determine whether it should certify that fact to the Secretary of the Treasury, the Secretary of the Treasury shall, upon request, forbid entry to such products until the Commission completes the necessary hearings; but the Secretary of the Treasury shall permit conditional entry of such products under bond.

TREASURY DEPARTMENT TO SECURE DATA

The Secretary of the Treasury has the right to inspect factories and accounts of any domestic producers of artcles in groups II and III. The information secured in this way shall be confidential and shall not be published except in the form of totals or averages which do not disclose the operations of individual manufacturers. In the present form of the bill this power is delegated to the Tariff Commission.

Another amendment, by Senator Spencer of Missouri, adds the following items to the bill: Camphor, natural and synthetic, crude and refined, 25 per cent; caffeine, $1.50 per lb.; chloral hydrate, 15c. per lb.

Crystallography of Alpha and Beta Iron

A Complete Classification of the Various Microscopic Appearances of Hypo-eutectoid Steels Based Upon the Hypothesis That Alpha Iron Has a Plate-like Habit While Beta Iron Has a Granular Habit

By FEDERICO GIOLITTI

NICOLAS BELAIEW, writing in the *Revue de Métallurgie*, 1910, p. 510, on "An Artificial Reproduction of Widmanstättian Structure in Carbon Steel," has brought to a successful conclusion the long and interesting series of attempts to reproduce the structure of meteoric iron in the laboratory. Osmond and Cartaud had already established the conditions of its formation as being extremely slow cooling, as compared to that of ordinary laboratory experiments. Such slow cooling gives time for a more or less complete decomposition of the non-magnetic solid solution existing in iron-nickel alloys at high temperatures, to the effect that the excess constituent is deposited along crystallographic planes parallel to faces of a regular octahedron. Belaiew, in turn, was able to reproduce in pure steels containing about 0.50 per cent carbon a completely analogous structure by the combination of a

Fig. 1. Widmanstättian structure in Belaiew's alloy No. 8; Carbon 0.55 per cent. × 4.5.

Fig. 2. Widmanstättian structure in Tazewell meteorite. × 3.

long high heat followed by extremely slow cooling. A glance at the micrograph, Fig. 1, showing one of his laboratory samples, and Fig. 2, meteoric iron from Tazewell, is sufficient.

WIDMANSTATTIAN STRUCTURE

This author calls attention to the essential similarity between the equilibria of iron and nickel as determined by Osmond[1] (Fig. 3) and the well known iron-carbon diagram (Fig. 4). Inspection shows that both nonmagnetic iron-nickel alloys and iron-carbon solid solution (austenite) decompose after solidification and on slow cooling into their constituents, of which the substance camacite corresponds to ferrite, taenite to cementite, and the eutectoid plessite is equivalent to the eutectoid pearlite. Consequently the phenomena attending a cooling of corresponding alloys are similar: primary crystallization passes through a mushy stage forming interlocked dendrites, whose habit in both cases is ordinarily the regular octahedron. Further cooling—extremely slow for meteorites — favors a uniform

[1]*Compt. Rend.*, 1899, vol. 128, p. 304.

orientation of the individual crystallites forming the solid solution into masses which are essentially huge allotriomorphic crystals. Upon cooling to the point where solution is saturated, secondary crystallization takes place; for low-nickel alloys, camacite separates from a constantly enriched solution, which latter finally breaks up into the eutectoid plessite. For low-iron alloys, ferrite first separates and the enriched austenite finally reaches eutectoid composition and reverts to pearlite.

Belaiew then points out that on extremely slow cooling one can expect super-cooling and spontaneous crystallization in large masses; a crystallization, it is important to note, from an already crystalline substance, under which condition it is commonly admitted that the subsequent phase collects along the crystalline planes of the precedent phase. He therefore argues that Widmanstättian structure depends entirely upon the orientation of the crystalline mass and in steels is independent of their carbon content. Therefore Osmond has been able to develop the same appearance in slowly cooled "burned" Swedish iron, and Belaiew also found very pronounced Widmanstättian structure in slowly cooled hyper-eutectoid steel.

STRUCTURE OF GREAT CRYSTALS AND RETICULAR STRUCTURE

Two years later *Stahl und Eisen*[2] printed an abstract of Chapter III of a Russian treatise by Captain Belaiew, "On the Crystallization and Structure of Slowly Cooled Steels," in which he notes the occurrence and describes the mode of formation of three distinct crystalline habits in such metal. He points out that during original
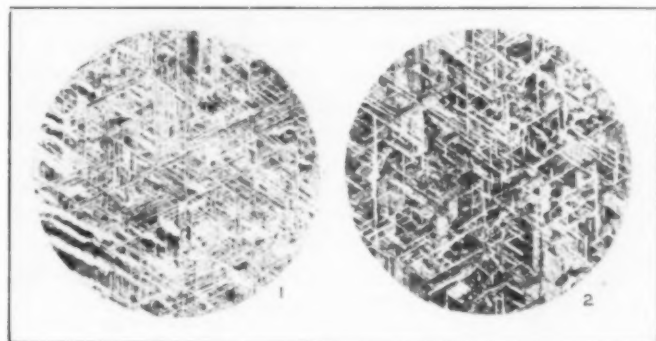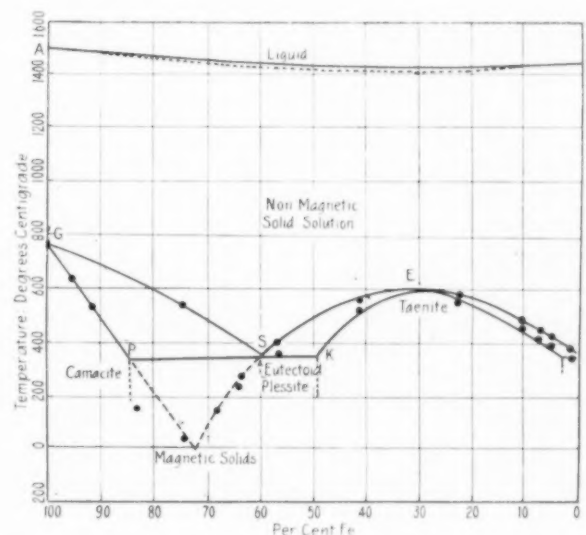
[2]1912, p. 1,273.

Fig. 3. Osmond's diagram for Fe:Ni alloys; reproduced from Gulliver; "Metallic Alloys."
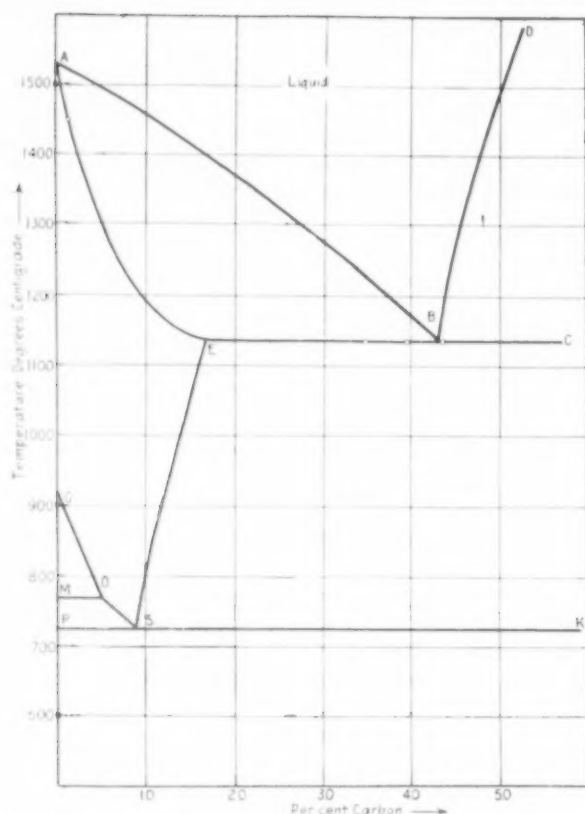
Fig. 4. Howe's diagram for Fe : C alloys; reproduced from Howe, "Metallography of Steel and Cast Iron."

solidification it is well known that the time in the mushy state and the difference in carbon concentration axis to center are ordinarily greater, the higher the carbon in the melt. (In other words, the liquidus *AB* and the solidus *AE* in Fig. 4 markedly diverge as carbon increases.) Slow secondary crystallization resulting from the austenitic dendrites formed during the mushy stage then causes:

First, excess ferrite to separate where there is the least and cementite where there is the most carbon in a non-uniform solid solution. Therefore ferrite appears at the axes of such hypo-eutectoid dendrites and cementite at the contacts of hyper-eutectoid dendrites. This results in what Belaiew calls "structure of great crystals," and is illustrated in Figs. 5 and 6.

Second, in solid solutions rendered homogeneous by long annealing or very slow cooling, ferrite (or cemen-

tite) is excluded to the borders of the primary crystals if the slowness of cooling from Ar_3 to Ar_1 is sufficient in comparison with the size of the dendrites so that the excess constituent can migrate the necessary distance. In such cases the microscopic appearance often seen in well-made commercial steels results. Belaiew calls it "reticular structure" (Fig. 7), whose network veins are the thicker the further the carbon content in the steel from the eutectoid.

Third, in homogeneous solid solutions cooled somewhat too rapidly for the excess constituent to reach the periphery of the austenite crystals, the bulk of it remains inside the original austenite grains, but seeks the crystallographic planes of octahedral primary crystallization, forming Widmanstättian structure (Fig. 1).

Belaiew goes on to point out that two or three of these structures may appear in the same piece of steel—for instance, network surrounding Widmanstättian areas is quite common. Apparently excess constituent preferably crystallizes about foreign inclusions such as slag and graphite, or on the walls of cavities. By very long cooling cementite sometimes crystallizes in its characteristic needle-like forms, following only the directions impressed by the octahedral austenite, in which case an aggregation of crystals results and not crystalline groups.

STRUCTURE FROM EQUALIZED AUSTENITE

After reading the articles of which the foregoing is a review, I communicated a paper to the Academy of Science of Turin on March 30, 1913, giving some observations on a piece of metal whose structure did not correspond to Belaiew's dicta. The sample in question consisted of a piece of sheet steel which had formed a heat-treatment muffle, whose interior had been filled with wood charcoal, and whose exterior had been constantly bathed by oxidizing gases. It had been heated about five months continually from 900 to 1,050 deg. C., never, even for a short time, falling below the lower temperature. It had been cooled in the furnace setting, requiring about $4\frac{1}{2}$ days to drop from 1,000 deg. C. to 150 deg. C.

Its average analysis follows:

Mn	0.40	Si	0.011
P	0.059	C	0.32
S	0.011		

Carbon, of course, varied uniformly from about 1 per cent at the inside to practically zero at the outside, due
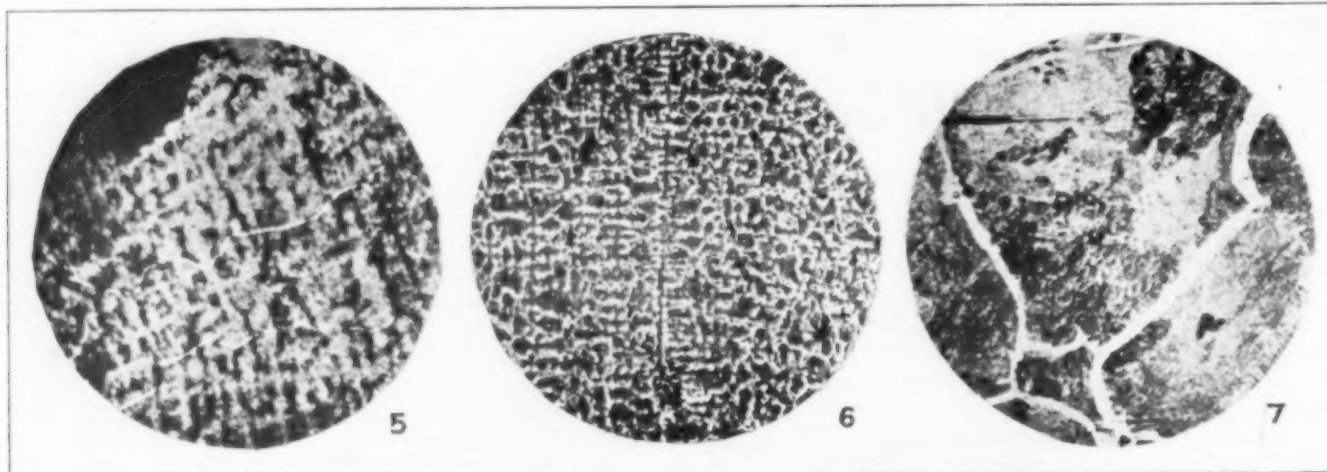

Fig. 5. Belaiew's "Structure of Great Crystals." Carbon 2.27 per cent. × 8.

Fig. 6. Network of ferrite between the dendrites (Belaiew). Carbon 0.60 per cent. × 9.

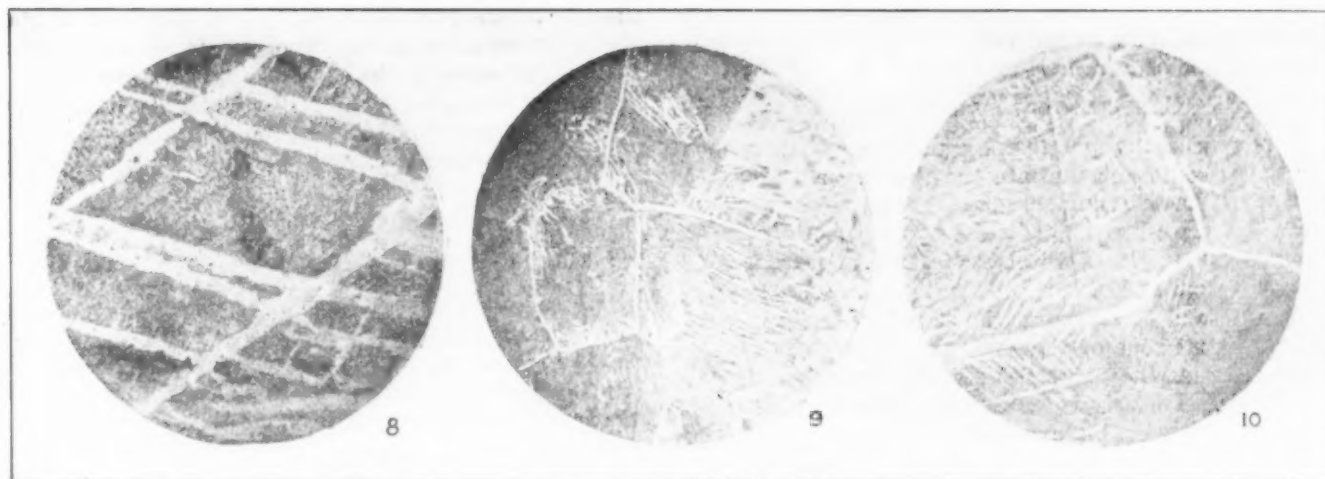Fig. 7. Belaiew's "Reticular Structure." Carbon 0.62 per cent. × 110.

Fig. 8. Widmanstättian structure in cementation muffle. Etched in 5 per cent picric acid in alcohol. × 60.

Fig. 9. Sample from cementation muffle reheated 8 hours to 1,000 deg. C., and air cooled. Picric acid etching. × 60.

Fig. 10. Same treatment as Fig. 9, but cooled in furnace. × 60.

to the fact that during use the carbon oxides had diffused continually through the metal.

Its very long sojourn at temperatures well within the austenitic area (*AGOSE*, Fig. 4) had given opportunity for even slowly moving soluble segregations to equalize their distribution throughout the metal. Continual diffusion of $CO:CO_2$ in equilibrium had also undoubtedly obliterated any non-uniformity in carbon which existed between axes and edges of the dendrites of primary crystallization and inherent by the mode of solidification. While it is not strictly true to say that the austenitic crystals were absolutely uniform in carbon concentration, since the plate is high in carbon at its inner edge and carbon free at its outer, still this uniform gradient across the plate is entirely independent of the older non-uniformity caused by solidification of mixed crystals.[‡]

Consequently Belaiew's conditions for the "structure of great crystals" are absent. Furthermore, the cooling from Ar_2 to Ar_1 was much slower in the furnace than that occurring in moderate sized pieces of cast steel in air which ordinarily exhibit Widmanstättian structure. Belaiew's views would require such a piece to have a "reticular" structure, yet Fig. 8, at 60 magnifications, shows a field of this metal having very coarse crystals and perfectly developed Widmanstättian structure!

Two 300-g. pieces like Fig. 8 were reheated for 8 hr. to 1,000 deg. C., one air cooled (½ hr. to 150 deg. C.) and the second furnace cooled (4 hr. to 150 deg. C.). At the end their microscopic appearances at 60 magnifications were as Figs. 9 and 10 respectively, thus demonstrating that at least for this particular steel very slow cooling favors perfect Widmanstättian rather than reticular structure. One should remember, however, that the history of the steel was quite different from the ordinary heat-treated pieces, whose time in the zone of gamma iron is too short for total equalization of all carbon, phosphorus and other elements forming solid solutions.

Two Crystalline Habits Distinguished

All cross-sections of the steel plate previously described, which when studied showed a wide range in carbon, also exhibited two distinct forms of ferrite crystals, the one characteristic of regions containing less than 0.4 per cent, where the ferrite existed in rounded

grains common to ordinary soft steel, and the other characteristic of higher carbon regions, where the ferrite existed as needles or striations in concordant groups, an appearance common to Widmanstättian structure. Both these crystalline habits are shown in Fig. 11, at 20 diameters.

Considering the history of the specimen, it is certain that all crystals of ferrite have formed from a solid solution free of "nuclei" of low-carbon content, and all have separated under precisely the same cooling conditions. The only difference in the condition of formation is that the rounded grains formed first, and at a higher temperature. In other words, the rounded particles separated from austenite as β iron along the line *GO* (Fig. 4) down to about 760 deg. C., while the plate-like laminations formed themselves as α iron along the line *OS* at a temperature below 760. In the first case the crystals of β iron were largely developed and then transformed bodily into α iron at 760 deg. As cooling continues, the last traces of excess ferrite separate themselves directly as α iron, but meeting with already-formed germs of crystallization, they deposit upon them, following their form.

Granting this, the first crystalline appearance separating from *uniform* low-carbon austenite and developing in large part above 760 deg. C. should be that characteristic of β iron—not rigorously in all crystallographic particulars, but possessing those morphological external characters of crystalline forms upon which depend many mechanical properties of the metal. The second crystalline appearance, separating from uniform austenite con-
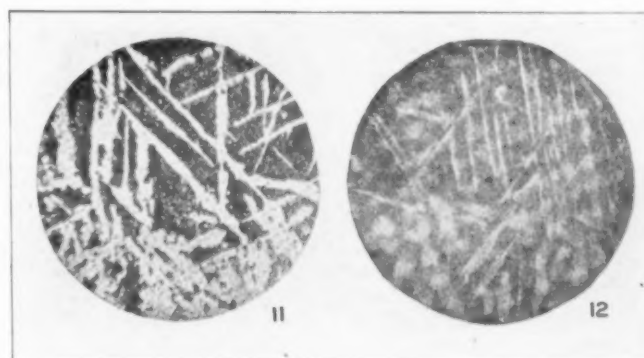
Figs. 11 and 12. Microstructure of cementation muffle where carbon concentration passes 0.4 per cent. Etched in 5 per cent picric acid in alcohol. × 20.

[‡] I use the term "mixed crystals" in the European sense, meaning to us what "solid solution" means to Americans.

taining somewhat more than 0.5 per cent carbon and developing entirely below 760 deg. C., should be that characteristic of α iron.

CONFIRMATORY OBSERVATIONS

A few of many possible confirmatory observations may be cited to substantiate the theory just advanced that β iron has a roundish, granular habit, while α iron has a flat plate-like habit, which I think satisfactorily explains the origin of all characteristic appearances of hypo-eutectoid steels.

Figs. 11 and 12 represent the structure, magnified 20 times, of that zone of the steel plate where the carbon content passes the point *O* (Fig. 4), from low carbon at the bottom nearly to eutectoid at the top. In each of these figures the features just explained may be seen; grains of ferrite in the low-carbon area which precipitated as β iron, and needles in the higher carbon area, which precipitated as α iron. Along the border zone between the two types of crystals one clearly sees some which may be called "composite," which have simultaneously the morphological characteristics of both series. By the theory, they should have roundish nuclei of β iron upon which form needle-like appendices of α iron. Actually this occurs, according to the well-supported hypothesis that slowly forming crystalline material of a second series deposits itself by preference on pre-existing nuclei, reproducing those contours only in cases where the originally formed mass is sufficiently preponderant in comparison with that of the later additions.

If my hypothesis be true, one must expect that should the crystallization process be disturbed by forging or other mechanical work, a barrier would be presented to the deposition of the α plates upon β granules, copying and preserving the roundish forms, and in such cases one would find α and β forms separating out in large part independently, and finally appearing side by side. Actually, Portevin and Bernard[1] show excellent micrographs of this kind, three of which are reproduced in Figs. 13, 14 and 15. Those authors, however, ascribe the appearance of Widmanstättian bands in forging to the fact that the pieces were held for a long time in the heating furnace at a temperature above 900 deg. C. (in Belaiew's "zone of granulation"), and the sub-

[1]"On the Structure of Some Forged Pieces; the Relation of Mechanical Properties and Widmanstättian Structure." *Revue de Métallurgie*, 1912, vol. 9, p. 544.

sequent cooling was rapid enough that the excess ferrite collected along the octahedral planes of the pre-existing austenite.

Consider the case of a mass of uniform austenite. After relatively rapid cooling my theory would call for a final appearance analogous to that of mechanically disturbed crystallization. This is exactly the case in regions of low-carbon content in Figs. 9 and 10.

CLASSIFICATION OF NON-SEGREGATED METAL

On the hypothesis that ordinary slowly cooled steel has superimposed in it two processes of crystallization, the final structure of steel depends mainly upon the uniformity of austenite, the speed of cooling through the critical range, the mechanical disturbances, and the carbon content.

1. For steels which have undergone treatment for *total* equalization of carbon, axis to periphery of each primary dendrite, the following classification holds:

A. Cooling very slow (furnace cooling) and undisturbed mechanically.

a. Carbon less than 0.35 per cent. Nuclei of β iron are prominent. Only those portions separating at temperatures less than 760 from a residue of enriched austenite come down as α iron, and even this tends to deposit on pre-existing masses of iron, also now transformed to α iron but pseudomorphous after β. Only in case the α iron formed in the second phase of cooling should be in preponderance can they develop in a noticeable measure by the side of the β appearances. (Figs. 11 and 12).

b. Carbon more than 0.4 per cent. All ferrite crystallizes directly into α iron, assuming its characteristic form well known as Widmanstättian structure (Fig. 8).

B. Cooling slow, and undisturbed mechanically.

a. Carbon less than 0.35 per cent. Crystallization takes place again in two steps as described above in *A,a,* separating as β and α iron successively. But in this instance the α iron cannot be so strongly influenced by the preformed β iron as formerly, and independently segregates into its own form. (Fig. 10.) Naturally the smaller speed of cooling will not permit α and β crystals to reach such large dimensions or perfect form, and the Widmanstättian structure degenerates into distorted striations.

b. Carbon more than 0.4 per cent. The structure still shows Widmanstättian bands but much more

Fig. 13. Unannealed forging with 0.25 per cent carbon. (Portevin and Bernard). × 140.

Fig. 14. Unannealed forging which failed in service. (Portevin and Bernard.) × 50.

Fig. 15. Unannealed forging which failed in service. (Portevin and Bernard.) × 90.
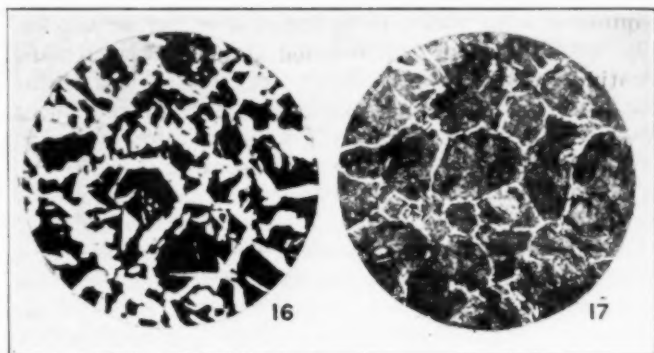
Fig. 16. Carbon steel (0.33 per cent) heated to 1,000 deg. C. and slowly cooled in furnace. (Hall, from Sauveur's "Metallography of Iron and Steel.") × 100.

Fig. 17. Carbon steel (0.50 per cent); heated to 1,000 deg. C. and cooled in air. (Burger, from Sauveur's "Metallography of Iron and Steel.") × 100.

imperfectly, in proportion to speed of cooling. If it is somewhat fast, the deformation of the ferrite crystals is sufficient to mask the plate-like structure.

C. Cooling slowly, with mechanical work finished very hot. Crystallization takes place analogous to *A,a* and *B,b,* but the effect of primary β crystals is less marked; the deformation separates efficaciously the elements formed in either phase. (Fig. 14.) In case the mechanical work is continued through the transformation range, all crystals are broken up and their original forms destroyed.

D. Cooling rapidly, with mechanical work, as in small drop forgings or stampings. Resulting forms are analogous to *C,* but the various crystalline elements are very small and often so poorly developed that it is difficult to distinguish one from the other.

CLASSIFICATION OF PARTIALLY EQUALIZED METAL

2. Some steels have had a prolonged annealing at high temperature, or a preliminary heating followed by a reheating at a lower temperature, yet the carbon content of the austenite crystals has not been completely equalized. Even in this case the phenomena proceed in a manner analogous to case 1, depend upon the same principal conditions, and are only modified by the presence of local difference of carbon concentration in each austenite crystal.

A. Cooling very slow (furnace cooling) and undisturbed mechanically. The first iron separates at those places where the carbon concentration is least, which ordinarily coincide with the nuclei of primary austenite. On account of the slow cooling over the temperature range corresponding to the separation of proeutectoid substance, the first portions separating have a maximum influence as nuclei on the accumulation of subsequently born material. It follows that the crystals of ferrite copy the form and disposition of the axes of the primary austenite, and there results that called "structure of large crystals" by Belaiew. In hyper-eutectoid steels cementite forms at the periphery of primary dendrites, *mutatis mutandis.*

B. Cooling slow, and undisturbed mechanically.

a. Carbon less than 0.35 per cent. The action is analogous to 2,*A,* just above, precipitated iron adapting itself readily, automatically, to the globular form of ferrite crystals, characteristic of slowly cooled, soft steels. In the final structure there can simultaneously appear the two characteristic forms of ferrite, separating in two phases. (Fig. 16.)

b. Hypo-eutectoid steels with an average composition of more than 0.35 per cent carbon. With low-carbon nuclei, germs of β iron may form, and crystallization is then completed by direct formation of α iron. However, if the average carbon is higher, crystallization of the excess constituent may initiate itself direct as α iron along the axes of primary austenite crystals. The characteristic development of α iron in elongated forms when the process is slow and uninfluenced by previous centers of crystallization operates so that ferrite develops into a spatial meshwork usual in steels containing from 0.40 to 0.75 per cent carbon when cooled after manufacture. (Fig. 17.) In other words, the platelike habit of α iron is suppressed by the influence of low-carbon axial nuclei if moderate time is given for migration of the crystallites. But if cooling is somewhat more rapid or the piece is hot-worked the germinal influence is interfered with and plate-like laminations appear alongside the meshes.

It may be noted that the structures described immediately above in 2,*B,a* and 2,*B,b* may both appear in the same piece should the difference in carbon concentration in the original austenite crystals be such that it is considerably less than 0.40 per cent at the axes, and as much more at the peripheries.

c. In hyper-eutectoid steels cementite separates as a rule at the high-carbon peripheries, crystallizing in deep-seated interiors only in case temperature drop is too rapid to allow sufficient migration.[5]

C. Slow cooling, with mechanical work. The disturbance is essentially shown by the elimination of the characteristic action of excess-constituent nuclei formed during solidification from the melt. Consequently theory and practice agree that the final metal contains the same structural elements as if slowly cooled without working, but they are independent of each other. (Figs. 13, 14 and 15.)

D. Rapid cooling, with mechanical work. This operates same as *C* immediately above, but each crystalline element is of smaller dimensions so that the two fundamental formations are distinguished with difficulty.

CONCLUSION

Hypo-eutectoid steels, especially, can therefore be classified and their structure explained by the hypothesis that β iron assumes a granular and α iron a laminar habit. Belaiew's observations also conform rather better than to his own explanation. Thus, his idea that ferrite is ejected to the periphery of homogeneous austenite on very slow cooling is not confirmed by study of a really uniform metal, which then actually gives Widmanstättian structure. His metal was probably somewhat non-uniform, and the reticular network resulting therefrom is better explained by case 2,*B,b.* This of course does not exclude the hypothesis that the peculiar Widmanstättian orientation should be closely related to the octahedral form of austenite, nor to derived elements like martensite. Furthermore Belaiew's remark that undercooling is partially responsible for Widmanstättian structure in slowly cooled steels is not justified by the steel plate I have examined. Here such structure is formed nearby nuclei in low-carbon regions, and under absolutely the same heat treatment, even forming a continuation of the nuclei themselves.

[5] See Howe & Levy, "The Life History of Pro-eutectoid Cementite," International Congress for Testing Materials, 1912, vol. 2, p. 1.

Observations on Catalyzers in Paint and Varnish Manufacture*

By F. P. Ingalls

CATALYZERS are useful industrially not only to bring about chemical reactions which otherwise would not occur but also to accelerate some which otherwise would be too slow. It is this second phase of the subject that is of special interest in the manufacture of paints and varnishes and concerns directly those highly important compounds known as "driers."

Without attempting to discuss the various kinds of paint or varnish, it is a general fact that when ready for application, whether it be by brushing, dipping or spraying, they are essentially liquid in form, although the consistency may vary considerably. This allows of easy application and is highly desirable, but by far more important is the facility with which they become solid after application and by simple exposure to the air are thus transformed into valuable protective coatings.

In paints this solidification, commonly known as "drying," takes place in the vehicle, and while the pigments may exercise a profound influence on the properties of the finished paint, there is no good evidence that the pigments themselves undergo any material change during the process. In varnishes, of course, the question of pigment does not enter.

This drying ensues from oxidation of the oil, accompanied usually, but not always, by evaporation of the volatile "thinner" which may be present, but only the oxidation of the oil is of interest to us at this time.

The liquids capable of oxidation and suitable for our requirements are few and occur among those substances designated as oils. Many oils absorb oxygen from the air by direct exposure, but only a few are transformed thereby into the kind of solid substance desired. Of these few, linseed oil is of paramount importance, and since its behavior with driers is so typical of all the others and consideration of them would take much time, we shall confine our remarks to the action of driers on this oil almost exclusively.

When linseed oil is exposed to the air it absorbs oxygen, increases in weight and volume, passes through a stage of highly increased viscosity and finally becomes a solid, tough, rubbery mass. The rapidity of this oxidation, perhaps indeed even its extent, is dependent upon a number of conditions, chief among which are the temperature and extent of surface exposed, especially the latter. Exposed in layers 0.001 to 0.003 in. in thickness, on glass plates, at a uniform temperature of 75 deg. F., it requires from about six to fifteen days (according to thickness of layer, quality and kind of oil) for the film to become "dry to touch," and in ordinary parlance is then said to be "dry," although it is very well and generally known that the film continues to harden progressively for a very long and indefinite time thereafter. Obviously, this reaction is very slow.

Action of Pigments on Oil Drying

If various pigment colors be incorporated with the oil by a process of mechanical grinding, and the mixture so obtained be spread out in thin layers as above, we observe some very remarkable differences in the drying time. Some pigments, as for instance umber, will shorten it to less than 24 hr., while others will

lengthen it into weeks, as in the case of carbon blacks; and certain of the aniline-color tannate lakes (made from magenta or methyl violet) may inhibit the oxidation of the oil to such an extent that even after months of exposure there remains only a sticky, gummy film in nowise acceptable as a good paint coating.

This quickening effect of umber has long been known; just how long is a matter of some doubt, but certainly for two or three hundred years. White lead, one of the most ancient of pigments, has also long been recognized as an accelerator of this drying process; but without attempting to follow the historical development, we may come down to the early half of the nineteenth century when good "boiled oil" and "oil varnishes" which dry in 24 hr. or less had become commercial commodities.

Boiled Oil Oxidation Theory

Because the best of these were prepared by heating the oil with metallic oxides, notably litharge and red lead, and because the oil was still further oxidized by the air during the heating process, there became prevalent a theory that the normal drying time was shortened by virtue of the fact that the oil so treated was already well oxidized and only a limited exposure was necessary to complete the process. This theory, although not now tenable, contained an element of truth, in that coatings with such oils gave harder films than most others made at that time and was further supported by numerous instances where oil which had merely been heated rather strongly in the air showed greatly increased drying power. Without direct knowledge of how this heating was done, nor under what circumstances, we may now assert quite positively that the increased drying power was due to some other circumstance than mere heat and the attendant air oxidation.

In 1867 Mulder undertook to explain the drying of oils, especially linseed, not only by itself but in conjunction with a number of substances introduced as driers.[1]

Little information or new facts were adduced until Hulb's classic research on the halogen absorption of the drying oils, and while his work was of immense value in the analytical identification and valuation of oils, it did not elucidate greatly the action of driers.

Unsaturated Fatty Acids

It had long been known that oils and fats were glycerol ethers (as they were then called, now esters) of fatty acids, and that these fatty acids were in many cases "unsaturated." This was shown by Chevreul, and his work was available to Mulder, but it was as late as 1890 that Hazura succeeded in identifying at least four unsaturated acids in linseed oil and first clearly brought to light the three fundamental substances upon which the drying power is based, and these acids he called linolic, linolenic and isolinolenic. Prior to this time these acids, together with oleic, which is the fourth, had

[1] After several series of experiments carefully conducted (and considerable conjecture which doesn't sound so very wild even today), he leaves the question open in the following words quoted directly from his book which we have before us:

"Worin besteht das Trocknen, das Festwerden? Liegt es in den Oelen allein oder auch in Beimischungen? Was wird nach dem Trocknen erzeugt?

"Ich glaube nicht, dass Jemand es weiss, denn ich habe bis jetzt nirgends eine Antwort auf die Fragen gefunden. Man spricht von Bleiseifen in Bleifarben, aber ist diese Bezeichnung wahr?"

["In what consists the drying, the solidifying? Is it due to the oil only or also to the admixtures? What takes place after drying?

"I do not think anybody knows, as I have been unable to find anywhere an answer to the question. We speak about lead-soaps in lead paints; is this designation correct?"]

been obtained often in the saponification of linseed oil, but all together, and in the absence of any good method of separation they had been bunched together under the name of "linoleic" acid. Even today, because there is no commercially available method of separation and since we get good commercial results without direct separation, this nomenclature is still retained, as we shall see a little later.

This last discovery makes it easy to understand why the more or less scientific development of driers should date from this time, and although this rapid historical sketch lays claim to no sort of completeness, or even rigid accuracy in all detail, it serves, nevertheless, to throw much light on the nature and source of these catalyzers or driers which are our chief topic.

DRYING PHENOMENON DEPENDENT ON CERTAIN METALS

What, then, are these catalyzers or driers? In a word, they are certain metallic salts of one or more of the unsaturated acids which characterize the drying oils. There are several metals which, when so combined, are more or less active, but cobalt, manganese and lead are so superior to all others that they are in a class by themselves. Copper and iron may yield driers of no mean order, but are less active than those named, as well as less desirable in other ways, and are never used commercially except under very special conditions. All others are negligible so far as known at present.

Based on the weight of metal present, cobalt and manganese are much more active than lead, but atom for atom the difference is not so great. Between cobalt and manganese there is comparatively no great difference, and until very recent times, when cobalt became cheap, it was never used commercially, although its activity as a drier was known and had been definitely established as early as 1892 to our certain knowledge.

It is fortunate, however, that we have all three, for the technical results obtained by their use show differences, aside from the mere question of activity, that are quite important, and as a matter of fact, the slower lead holds the position of chief importance, although it is rarely used alone, but more generally in conjunction with either manganese or cobalt and occasionally both.

Mulder showed very conclusively that the activity of umber was due, not at all to the ferric oxide, silicon and silicates, of which it was more than four-fifths composed, but to the manganese oxide, which constituted less than one-fifth. He also showed that with both oxides of lead (litharge and red lead) the full effect was obtained only by heating them in the oil and that only a small quantity (a few per cent by weight) was necessary to achieve this result. When oil is so treated the oxides disappear at a rate largely dependent on the temperature and the fineness of the oxide, and although on subsequent standing a noticeable precipitate falls to the bottom, there is no free oxide either in the precipitate or suspended in the oil; but if the clear oil is analyzed, most of the lead is found there, in soluble form, and the oil will dry in hours where it required days before. What has occurred is readily understood. The oil has been partially hydrolized; the freed acids have united with the lead; those lead salts which are insoluble in the remaining oil have settled out; and the soluble ones are dissolved. It is these soluble lead soaps which accelerate the oxidation. This view is substantiated by a number of significant facts.

If oil be heated with almost any of the normal salts of either lead or manganese, acceleration is observed only with those salts which are readily broken down or dissociated at the temperature used. Wherever the metal is too firmly bound to be at least partially dissociated under the conditions of heating there is little or no acceleration. The sulphates, nitrates, chlorides, etc., are of no value as driers, but the acetates and borates are good driers, especially the borate of manganese, which, however, requires a rather high heat to yield its maximum effect. It might be expected that a substance such as lead tri-ethyl would be a good drier. It is a clear, nearly water white, mobile liquid, containing about 70 per cent of lead and freely soluble in linseed oil. We have a small sample for inspection. It is useless as a drier in the cold, and if it must be heated to decomposition, litharge is cheaper. Finally, if the oil be hydrolized with caustic alkali and the resultant soap made into other soaps by the addition of water-soluble salts of lead, manganese or cobalt, fatty acid salts may be made which contain nearly if not quite the theoretical proportion of metal, and when these are dissolved in plain raw oil the accelerating effect is unsurpassed by any other means. These are the so-called "linoleates" of lead, manganese and cobalt, although we have seen that there are at least four unsaturated acids present, to say nothing of the small proportion of saturated acids which are also present in linseed oil. Linoleic acid as an individual is not recognized here except commercially. Many other "linoleates" have been tried, as for instance cerium, of which we have a small sample for inspection, but practically all are inactive. Cerium and vanadium, however, are powerful catalysts in the oxidation of aniline by sodium chlorate.

Some little further investigation is necessary to show which of these aggregated metallic salts are the most active. The saturated salts are essentially insoluble, form no appreciable part of the finished oil, and may be disregarded. The unsaturated acids are difficult of separation either by themselves or in their salts. We can get oleic acid, however, quite readily and in pure form. When the oleates of lead, manganese and cobalt are used as driers, they have indeed considerable power, but they are not so active as the "linoleates" nor do they remain quite so readily in solution. This leads to the conviction that the salts of the $C_nH_{2n-4}O_2$ and $C_nH_{2n-6}O^2$ acids furnish most of the drying power, but it is not yet clearly proved to what extent these differ in activity from each other.

DRIER METAL LINOLEATES

We have already seen that these linoleates are readily formed when the oil is directly heated with a small quantity of the oxides. If the proportion of oxide is increased, more linoleate is formed, and this may be carried virtually to the theoretical limit, though in practice it is seldom done. Linoleates made in this way are highly oxidized during the process. Although the surface exposed is relatively small, the oxidation is rapid because of the presence of the metallic soap and the high heat (300 to 500 deg. F.) and especially when red lead and manganese dioxide are used. Consequently also they are very dark colored. If the cooking is not too long continued, there results an almost black molasses-candy-like mass which dissolves quite freely in turpentine, and is the basis of the so-called japans or japan driers. They are fully as powerful as the "pre-

cipitated" linoleates and have been in use for a much longer time. Special kinds for many purposes contain added resins of one sort or another, but so far as we know the catalytic power is not increased thereby, although in technical practice the intelligent selection of drier is a matter of high importance.

We see from this that these soaps of the unsaturated acids do not have to remain unsaturated to retain their power. They may at least be quite highly oxidized, and this brings us to the consideration of some other compounds of the same metals with organic acids having little or no obvious relation to those discussed. The first of these are the "resinates"; in other words, those made from common rosin.

PRECIPITATED RESINATES

.If rosin be dissolved in dilute alkali and precipitated with soluble metallic salts from aqueous solution, we get the "precipitated resinates." If the oxides be heated directly with rosin, we get "fused resinates," and these are also frequently made by melting the precipitated resinates with an excess of rosin. They are driers of good power and quite extensively used. A discussion of their relative merits is out of place here and there are differences of opinion concerning their actual value.

CHINA WOOD OIL

Finally, we have the soaps derived from tung oil (china wood oil). Used from time immemorial in China for waterproofing purposes, it has been used in this country only since very recent times. It dries even more rapidly than linseed, but in a very peculiar way which precludes its direct use in paints or varnishes. The film has the appearance of frosted glass, and looks as if some soluble substance had crystallized out, but as a matter of fact the appearance is due to a multitude of very fine wrinkles and is a case of excessive "crimp." It is a very valuable oil, however, and has almost revolutionized the varnish industry because of its very hard film. The acids are unsaturated to about the same extent as those from linseed, as is shown by the iodine number, but in other respects are widely different. Lead, manganese and cobalt soaps of them, however, show similar catalytic activity. In fact, aside from purely technical considerations, we may use the linoleates, tungates and resinates almost indiscriminately either alone or with each other in any kind of drying oil, without noticeable inhibition of individual activity.

SPEED OF DRYING

Concerning the quantity of these driers required to produce the maximum acceleration, much depends on conditions. Unless the metal is in solution or retained in what may be termed the active field, it has little or no power. Whether the solution is crystalloidal, partly colloidal or wholly colloidal is open to discussion, but when a precipitate forms it is (at least relatively) inactive, even though it may retain considerable metal.

Roughly speaking, it is easy to bring the drying time down to 7 or 8 hr. for linseed oil, but to go below this time requires extraordinary drier. With lead alone it is difficult to reach this speed with any amount within reason. With manganese three to five parts in 10,000 will suffice. Cobalt requires about the same, perhaps slightly less. These figures indicate the actual metal in the active field as shown by analysis of the *clear oil*, and may be widely different from the amounts put in when preparing it. The films must be less than 0.002 in. thick and the temperature about 75 deg. F.

It is difficult to establish definite limits of this sort on account of the many variable factors.

CHOICE OF DRIER

In conclusion, it is perhaps desirable to say a few words bearing on the technical choice of drier for different uses. It has been noted that lead is slower than manganese or cobalt, but its influence on the character of the film is very favorable. This was noted by Mulder, and he describes it by saying it is "tough, like rubber," while manganese gives a film "tough, like leather." At any rate the film is rounder and fuller, does not expand so much and therefore does not wrinkle up so decidedly in forming, where it happens to be a little too thick. This is known as "crimping." Manganese, on the other hand, dries faster, expands more, gives a coat that looks thin or skimpy, and has a decided tendency to crimp. In general, cobalt films are similar to manganese films. In all cases, however, much depends upon how they are incorporated into the oil.

Both manganese and cobalt impart a darker color to the oil than lead, but on account of their greater activity may be used in much smaller quantity and the difference largely overcome in this way. Further, if the quantity of metal is small, the oil will bleach out on drying; nevertheless in the presence of turpentine high color is liable to develop.

In general practice, therefore, it is customary to use lead for character, and jack it up with manganese or cobalt for speed. A good strong-drying oil will generally show on analysis, in parts per 10,000: lead, 50 to 150, and manganese 5 to 15. When cobalt is found, the quantity is usually smaller than the manganese unless used in its place, in which case the quantity required is approximately the same. It is claimed that cobalt will give a lighter colored oil than manganese for the same speed; this may be true, but much depends upon the method of production.

Whether these substances are true catalysts acting by their mere presence, or whether they depend on a rapid vibratory alternate oxidation and reduction may be elucidated at some future time, but we are certainly fortunate in having them at our disposal in the present.

J. W. Masury & Son,
Brooklyn, N. Y.

Sag Paste for Burns

During the war large quantities of sag paste were purchased by the Government, principally for the treatment of gas burns. The paste was prepared by a large number of manufacturers according to the following formulæ:

FORMULA 66

	Parts by Wt.
Zinc oxide, 100 mesh, U. S. P.	40
Benzoinated lard	20
Refined raw linseed oil	20
Adeps lanae, U. S. P.	20
Coloring matter	1

FORMULA 146

	Parts by Wt.
Zinc oxide, 100 mesh, U. S. P.	45
Benzoinated lard	10
Raw refined linseed oil	30
Adeps lanae, U. S. P.	15

FORMULA XII-A

	Per Cent
Soya bean oil	62
Zinc stearate	38

This paste was put up in collapsible metal tubes in several sizes.

Commercial Development of Fused Silica

An Account of the Development of the Electrothermal Processes of Fusing Glass Sand—Reactions Between Carbon and Silica and Application of Gas Phases to Process—Properties of Product Physically Explained

BY JOHN SCHARL* AND WALLACE SAVAGE

WHILE fused silica has attracted the attention of many scientists[1] for the past eighty years, it has been within the latter part of the last twenty that it has had any large technical application. This was due primarily to the lack of demand rather than knowledge of methods of fusing. As early as 1849, eighteen years before the invention of the dynamo, Despretz fused silica by passing the current from 600 bunsen cells through a small carbon rod[2] embedded in sand. He obtained a very hard tube with six times the diameter of the original electrode. This tube probably consisted of a core of the various products of reaction between carbon and silica within a mass of fused sand. In 1886 E. H. and A. C. Cowles[3] experimented with fused sand in their well-known granular resistor-type electric furnace. They took out patents on the carbon reduction products obtained from the silica, but did not recognize their composition or application until 1896, when E. G. Acheson[4] put commercial carborundum on exhibition at the World's Fair at Chicago. Immediately after this, the chemistry of the reaction products involved was studied and found to be represented by the following equations and equilibriums:

$$SiO_2 + C = CO + SiO \qquad (1)$$
$$SiO + C = SiCO \leftrightharpoons CO + Si \qquad (2)$$
$$Si + C \leftrightharpoons SiC \qquad (3)$$
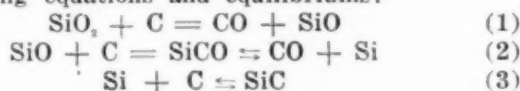
In reaction 1, the silicon monoxide is a gas which upon cooling condenses directly into an extremely light powder weighing only 40 oz. to the cubic foot and known in commerce as monox. In reactions 2 and 3 the silicon is in the gaseous state and condenses to the liquid before solidifying. The products produced in the third reaction depend entirely upon the temperature used. Around 1,600 deg. C. amorphous carborundum is said to be produced; above 1,850 deg., the melting point of silica at pressures where the liquid phase exists, carborundum crystals form; and in the environs of 2,240 deg., the reaction goes to the left, producing graphite and silicon gas.

FUSED ROCK CRYSTAL WARE

In 1901 Shenstone[5] developed a process for making fused silica ware with the oxy-hydrogen flame. He heated Brazilian rock crystal quartz to 1,000 deg. C. and quenched it in cold water, thus breaking up the

silica at the points of temperature strain. These pieces, as they did not tend to shatter after this treatment, were fused into pellets by means of the 2,000-deg. oxy-hydrogen flame, and were then drawn into fine rods. The fused silica rods, reheated and in the softened state, were wound on a platinum rod. By this means the operator was able to build up a fused silica tube which could be blown into any form desired without calling for greater skill than has been exhibited by glass blowers for the past 3,500 years.

Almost simultaneously, Heraeus[6] worked out the problem of obtaining molten silica in a form suitable for blowing. He fused rock crystal directly on iridium and later zirconia, with the oxy-hydrogen flame and then applied the usual glass-forming processes.

The ware made from rock crystal is very transparent and is mostly used in thermometer stems and ultraviolet ray tubes, due to its low expansion and nonabsorption of short-wave light.

PECULIAR PHENOMENA OF FUSED SILICA

When the crystalline forms of silica are heated, they expand 781×10^{-8} per deg. C. per unit of length on the main axis and 1419×10^{-8} in the cross-section, thus setting up a considerable as well as uneven strain, when suddenly cooled through a large temperature range. If the heating is carried on slowly enough, crystobalite crystals will be formed which at higher temperature will invert to tridymite.

At about 1,400 deg. C. the small content of impurities, which exist in amounts of about 0.2 per cent in the purest silica commercially obtainable, will begin to show signs of weak fluxing activity and the mass will begin to cohere, even though the temperature is at least 450 deg. below the theoretical melting point of pure silica. As the temperature increases, the mass grows more and more viscid until a temperature of about 1,750 deg. is reached, when it begins to sublime. In this, the highest state of fusion obtainable at atmospheric pressure, the thermal expansion of the silica will be about 17 per cent of the original volume of crystal solids. After rapid cooling to atmospheric temperature, the thermal contraction in volume will be found to be only about 0.07 per cent. This remarkable property of a solid maintaining almost the fusion volume throughout so great a temperature range without exhibiting any tension strains is scientifically unexplainable as well as unique with this product. According to Henning and Randall, the coefficient of expansion for fused silica at 200 deg. is 518×10^{-9}; at 900 deg., 538×10^{-9}; and at 1,100 deg., 583×10^{-9}, which indicates that a rod one meter long with a temperature change of 1,000 deg. C. or 1,800 F. will be expanded

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[1] Gaudin succeeded in fusing small beads with a blow pipe and drawing them in 1839. He observed that it was optically inactive. (*Comp. Rend.*, vol. 8, pp. 678, 711.) Gautier produced capillary tubes of it in 1869, which he exhibited in Paris in 1878. (*Comp. Rend.*, vol. 130, p. 816.) Boys obtained fine cords of it by drawing fused beads out by means of an arrow suddenly released from a bow. They were so small in diameter that it was necessary to use a magnifying glass to find them. The cords were used in suspending mirrors in galvanometers, etc. [Eng. Pat. (1889) 4,849.]

[2] *Comp. Rend.*, vol. 28, p. 755; vol. 29, pp. 48, 545, 712, 720.

[3] *Proc. Soc. Arts*, Boston, 1886, p. 74.

[4] U. S. Pats. 492,767 and 560,291.

[5] *Proc. Royal Inst.*, London. *Nature*, May 6, 1901.

[6] Fifth Inter. Cong. App. Chem. D. R. Pats. 175,385; 179,576; 172,466.

upon heating or contracted upon cooling only slightly over one-half millimeter.

Care has to be exerted not to maintain fused silica for long periods at temperatures between 1,150 and 1,400 deg. C., which is its range of devitrification. In all probability this phenomenon is the formation of tridymite crystals and the segregation of the various impurities previously mentioned. The resulting devitrified product is weak mechanically. It expands and contracts like ordinary quartz from fifteen to thirty times as much as fused silica, and if, after heating, it is quenched in cold water, it cracks. The rate of devitrification is very low at 1,150 deg., but increases rapidly toward 1,400 deg. Usually this phenomenon can be counteracted by heating to white heat, temperatures above 1,400 deg. C., and rapidly cooling below 1,150 deg., where it is permanently stable, though well out of its normal slow-cooling crystalline phase. Doubtlessly, the phenomena here exhibited justify the application of the theory of solid solution developed in connection with high flux content glasses to fused silica. In this case the silica should be considered the solvent and the impurities the solutes, which in their amounts and effects on the fusion temperatures are analogous to carbon and the like in steels. The chemistry of the phenomenon of solid solution probably will find no better opportunity for development than is exhibited here, and knowledge of fundamental importance to the science of ceramics should be derived at the same time.

ELECTROTHERMAL PROCESSES DEVELOPED

Immediately after the value of fused silica had become generally known by means of the laboratory ware produced by Shenstone in England and Heraeus in Germany, several technical men undertook to develop a more economical product. Glass-makers' sand was
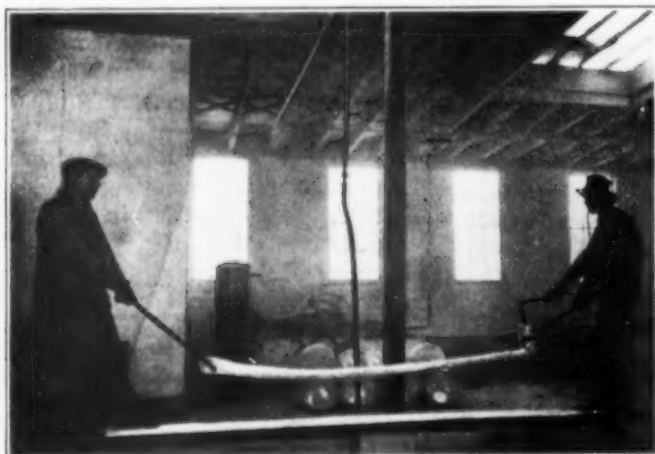
FIG. 1. DRAWING TUBE ON CHANNEL IRON BENCH

employed in the place of rock crystal, and the electric-resistance furnace instead of the oxy-hydrogen flame. In 1902 Dr. R. S. Hutton[7] reported his investigations of fusing sand, which he found to be most successfully accomplished by means of embedding a graphite rod in sand and heating with a current of high amperage. The fused silica did not apparently react with or adhere to the hot electrode, due to the formation of intervening gases. These undoubtedly consisted of vaporized silica, which, in turn, being in contact with the hot graphite electrode, formed the various carbo-

[7]*Trans.*, Am. Electrochem. Soc., 1902.

silica reaction gases previously discussed in connection with carborundum. A white opaque tube was obtained, due to the fact that the silica could not be heated to the liquid state and the gas cells originating from the interstices of the sand were locked in similarly to the leavening gases in dough. They were of microscopic size, however, and gave the product a beautiful satin white finish. Day, Shephard and Mehner believed that liquid silica could be produced by fusing the sand under pressure, and a transparent product free from gas inclusions obtained. Their experimental work was not carried to a successful conclusion, though their idea was fundamentally sound. However, what the lowest vapor pressure of liquid silica actually is, and what pressure

FIG. 2. TYPES OF LABORATORY WARE

of silica gas is in equilibrium with the fluid silica of sufficiently low viscosity to release automatical'y these imprisoned gas cells, are both unknown bits of scientific information.

DEVELOPMENT OF COMMERCIAL PRODUCTION

Although Hutton had obtained a molten tube of silica which could have been manipulated by most any skilled glass blower in producing all varieties of fused silica ware, no blowing was attempted, even though Shenstone had published a description of his process of blowing fused rock crystal tubes the year before. Elihu Thompson[8] took out the first patent on forming fused sand, in which he claimed the use of shaped electrodes in producing hollow silica ware.

In 1904 Dr. James Francis Bottomley,[9] Sir Arthur Paget and Dr. Robert Salmon Hutton, by applying vitrifacturing engineering, were able to devise a process for obtaining a ware from fused sand, which they produced at Wallsend-on-Tyne, England, under the firm name of Thermal Syndicate, Ltd., and trade named and marked Vitreosil.

In Germany, Ludwig Bolle & Co. for a time acted as distributors for the fused silica products of the Thermal Syndicate, and through this connection Dr. August Voelker, a partner of Bolle, became interested in the industry. In 1907 he took out a series of patents[10] on the basis of which the Deutsche Quarzglas Gesellschaft commenced the production of Sidio Fused Silica. In 1911 the Cölner Fabrik für feuer und säuerefestes Glas took over the Voelker patents and Sidio works and started operating.

Recently the Deutsch - Englische Quarzchmelze-Pankow, Berlin, using the patents of the Thermal

[8]U. S. Pat. 778,286.
[9]Eng. Pats. 10,670 and 18,434 (1904). U. S. Pats. (1906) 812,399; 822,424; 836,558-9 and R. I. 13,504. *Jour. Soc. Chem. Ind.*, vol. 36, pp. 577-580.
[10]D. R. P. 204,537; 204,853-4. Eng. Pats. (1907) 5,764; (1909) 18,713. U. S. Pats. 989,671; 1,051,035-6; 1,068,716 and 1,107,386-7.

Syndicate, absorbed the interests of the Cölner Fabrik, thereby combining the two processes. In France, fused silica products are manufactured by Le Quartz Fondù, which manufactures in accordance with the process of Dr. August Voelker.

The United States is the only large industrial country that has in the past decade been extensively supplied by imported fused silica products. These materials have found large and important applications in many fundamental industries. Because it has become undesirable as well as inconvenient to remain dependent on imported supplies entirely, the General Ceramics Co. has taken up their manufacture and erected a well-equipped plant in connection with its Chemical Stoneware Works at Keasbey, N. J. The company is thus prepared to build every part that goes into high-grade
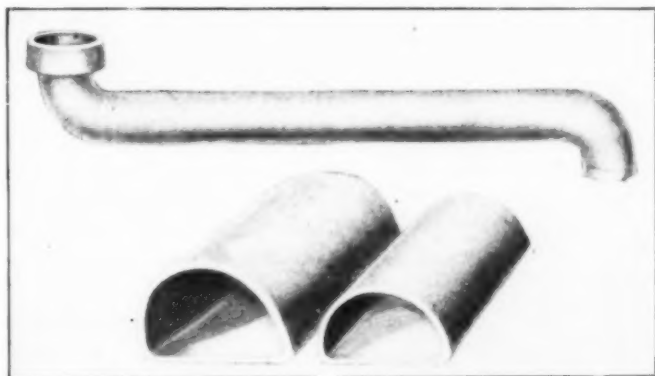
FIG. 3. MUFFLES AND CONDENSER PIPES

acid-plant installations, in the stoneware portions of which it has experienced marked success.

Previously to beginning operations on fused silica, about a year was spent in perfecting the equipment. The electric furnaces used are of extremely simple design, consisting of no more than an inch Acheson graphite rod about $3\frac{1}{2}$ ft. long embedded in the highest grade glass sand obtainable. As soon as the patent applications have been allowed, the details of both the methods of fusing and blowing will be published. In making tubes, the fused tubular mass is drawn out to the length which gives the desired diameter and then laid on a flat runway of channel iron to straighten before cooling. (Fig. 1.) Iron molds of similar construction to those used in making bottles are used in forming all the usual types of blown ware from the hot stock. In these latter operations, the usual procedure of the modern glass-blowing art is followed. Views of some of the various types of products produced are shown in Figs. 2 and 3. The rough blown ware is finished by grinding with carborundum wheels and air blasts.

SEMI-TRANSLUCENT FUSED SILICA

If opaque fused silica is quickly heated a second time to over 1,800 deg. C. with either an oxy-hydrogen flame or an electric arc, the cellular structure collapses, giving a semi-translucent product. The hot gases originally occupying these minute cells undoubtedly consisted of a mixture of air and silica vapor. Upon cooling, the silica condensed to the solid state, leaving the air in the cells in a very rarefied state. These voids amount to approximately 6 per cent of the volume of the opaque fused silica. Upon sudden heating and softening, the walls seem to collapse before the silica has time to produce sufficient gas pressure to support them in equilibrium

with the external atmospheric air pressure. Fig. 4 illustrates a two-phase Rennerfelt arc furnace in operation producing semi-transparent ware. This ware is a better conductor of heat, is stronger, has greater resistance to abrasion and therefore is more easily kept constant in weight than the first fused opaque ware.

IMPORTANT PROPERTIES OF FUSED SILICA

As every one must appreciate, the most valuable property of fused silica is its resistance to temperature shocks, which, in combination with the fact that it is acid-proof,[1] abraded with difficulty and the only vitreous material that is absolutely insoluble in water, makes it almost as estimable as platinum in both the laboratory and the plant. Combustion tubes of it can be heated to temperatures as high as 1,100 deg. C. at pressures of four atmospheres or *in vacuo* without causing difficulties. At the highest heats the stoppers in the ends of these combustion tubes are transformed to neither charred cork nor fused rubber, due to the low longitudinal heat conductivity at moderate temperatures of this material, which is composed of an accumulation of millions of minute rarefied gas cells. In this property, these cells have certainly contributed a very valuable service to scientific work of a far-reaching nature.

Fused silica is an ideal electrical insulator as well as a permanent one, because it contains no decomposition products, such as soda or potash, which tend to
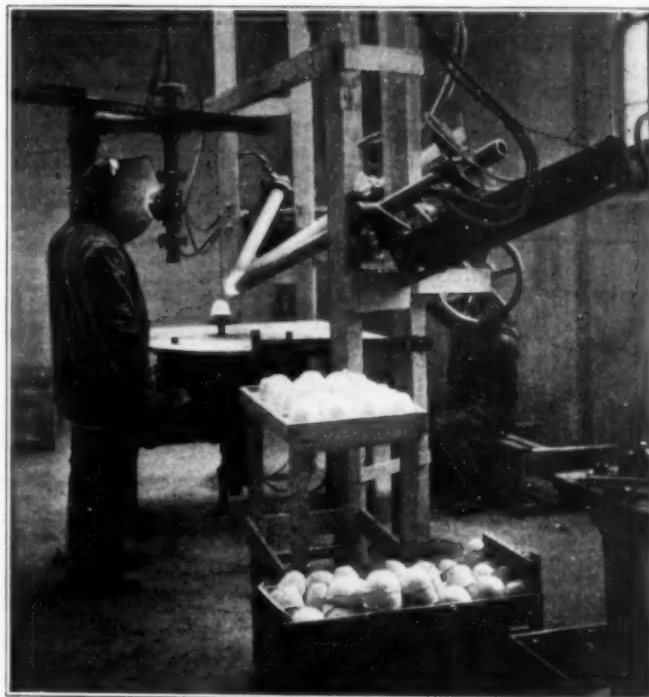
FIG. 4. REFUSION PROCESS FOR PRODUCING SEMI-TRANSPARENT WARE

collect moisture and form solutions of electrolytes on its surface. Its refractory properties stand it in good stead for high-temperature insulation. At the present time, an experimental investigation is being made on methods of producing spark plug insulators of it economically enough to compete with porcelain. It is believed there will be less trouble experienced with short circuits from cracks formed by thermal shocks in the case of fused silica.

[1]Hydrofluoric acid reacts with it, forming SiF_4, H_2SiF_6; and phosphoric acid and other fluxes attack it at temperatures above 400 deg. C.

The Electric Furnace Reduction of Garnet

BY M. deKAY THOMPSON AND JOHN DAVENPORT
(Analytical Work by Max Knobel)

A SERIES of experiments were made with the object of determining whether the silicon and iron present in abrasive garnet could be removed as ferrosilicon and a slag or aluminous residue produced which would contain a higher percentage of alumina than the original garnet. This residue, on account of its higher percentage of alumina and hardness, should possess good abrasive qualities when used against low-tensile-strength metallic materials. The alloy produced would, of course, have value as ferrosilicon.

MATERIAL AND APPARATUS

The garnet used was from the mine of the United Mineral Co. at South Danbury, N. H. This garnet is the regular red abrasive garnet used in coating paper to make abrasive garnet paper, and it has the following chemical composition:

	Per Cent		Per Cent
Silica	35.0	Calcium oxide	1.3
Alumina	27.0	Magnesium oxide	2.2
		Remainder iron oxide.	

The garnet grains used were about $\frac{1}{16}$ in. in diameter. Ordinary coke with 10 per cent ash was the reducing agent. The furnace consisted of a square firebrick shaft 18 in. outside diameter and 9 in. inside by 16 in. deep, built up on a piece of boiler-plate. The bottom of the shaft was filled with granular carbon to a depth of about 6 in., and a graphite plate was placed on top of this. In order to give good electrical contact between the boiler-plate and carbon, nine iron rods 2 in. long and driven into the boiler-plate projected upward into the carbon. The bricks were held in place by angle irons and the cracks were filled from the outside with fireclay. A carbon-tar mixture was also used in making tight the bottom where necessary. The tap-hole was formed by means of an iron rod and tap-hole fireclay, as is done in copper blast-furnace settlers. The furnace had a firebrick cover. The boiler-plate formed one electrode, and a 2-in. graphite rod, suspended vertically in the center of the furnace shaft, was the other. A 150-kw. transformer, with voltage regulation in steps of ten volts, served as a source of power.

METHOD OF OPERATION

The method of operating was to start the arc by means of a small piece of carbon placed between the movable, vertical electrode and the graphite furnace bottom. The charge was then fed in as desired. During operation a bright silicon flame, together with a blue carbon monoxide flame, was given off, and there was considerable volatilization, during a run.

It was difficult to get both the alloy and the slag into solution for analysis. Each was fused in a nickel crucible with a one-to-one mixture of sodium carbonate and sodium peroxide. The nickel crucibles were rapidly destroyed.

RESULTS

The results, as shown in the accompanying table, were encouraging. It will be seen from runs 8 and 10 that the alumina in the slag was about 62 per cent, or the concentration was more than twice that in the original garnet. The ferrosilicon contained 24 per cent to 26 per cent silicon and from 5 per cent to 10 per cent aluminum. It will be noted that all of the iron was removed from the slag and about half of the silicon. A 27 per cent excess of coke (No. 3) gave as complete reduction as 37 per cent excess coke. The addition of sawdust did not make a product which differed in appearance from that made with coke alone. These results were encouraging enough to have this reduction tried on a larger scale.

No.	Duration in Min.	Kw.	Kg. of Garnet	Kg. of Coke	Excess Coke Above Theoretical to Reduce All Fe and Si	Kg. of Alloy Produced	Analysis of Alloy, Per Cent	Kg. of Slag Produced	Analysis of Slag, Per Cent	Per Cent of Garnet Made Into Alloy	Per Cent of Garnet Made Into Slag
1	165	30-40	13.6	3.2	0	2.7	......	3.9	....	20.7	28.8
2	120	30-40	18.0	4.1	-5	3.8	......	8.1	....	21.2	45.0
3	240	30-50	34.0	10.3	27	11.9	Si26	14.5	SiO2 19.3	35.0	41.3
4	135	30-70	20.0	7.3	44	6.7	Si26	8.5	SiO2 19.3	33.5	42.5
5	240	50	25.0	9.1	44		......	......	....		
6	210	50	25.0	7.6	28	8.6	......	13.8		34.5	55.0
8	190	50	15.0	4.9	37	5.3	{Fe62.3, Si25.9, Al11.6}	2.9	{SiO2 29.6, Al2O3 61.5, CaO MgO 9.9}	35.5	19.3
9	180	40	15.0	4.9	37	4.1	......	4.7		27.4	31.4
10	165	50	30.0	9.8	37	5.9	{Fe69.6, Si23.8, Al5.6}		{SiO2 18.1, Al2O3 62.1, CaO6.5, MgO2.5}		

Run No. Remarks:

3	1 in. of slag fused solid at bottom; above, several inches of porous material.
4	Fraction of inch of fused slag at bottom, with several inches of porous material above.
5	Charge had 1.5 kg. sawdust. Alloy did not run together.
6	Charge had 1 kg. sawdust.
8	Furnace lined with graphite plates.
10	Furnace 13.5 x 13.5 in. to remove brick walls from heating zone.

The work was therefore carried on at the General Electric plant at Schenectady, N. Y., where even better results were obtained due to the large-scale operation.

It is probable that more silicon could have been removed if the garnet and coke had been ground to a fine powder, well mixed and briquetted with tar as a binder, but this has not yet been tried.

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Ferromanganese Not Covered by War Minerals Relief Act

The Attorney General of the United States has handed down an opinion to the effect that producers of ferromanganese are not entitled to reimbursement under the War Minerals Relief act, for losses incurred in its manufacture. The opinion was rendered at the request of the Secretary of the Interior in connection with the claim of the Anaconda Copper Mining Co. for $561,346.62 for losses sustained in producing and in preparing to produce ferromanganese. "The claim of the Anaconda company," says the Attorney General, "evidently is based upon the contention that ferromanganese is an intermediate metallurgical product of manganese and is embraced within the provision for payment of losses to producers by reason of the specific mention of intermediate metallurgical products in the act of Oct. 5, 1918, and the adoption of the minerals enumerated in that act in the first paragraph of section 5 of the act of March 2, 1919. There is, however, no basis for this contention, as the intermediate metallurgical products, metals, alloys and chemical compounds covered by the act are all specifically named in the act of Oct. 5, and as there is no reference to ferromanganese, the rule of law *expressio unius exclusio alterius* applies."

How the British Chemists Are Organizing

A Study in Professional Politics and Economic Conditions—British Industry Must Recognize the Importance and Value of the Chemist—Labor Party and Policy Not Attractive to English Chemists

By FREDERICK E. HAMER
Editor, *Chemical Age* (London)

ONE may confidently begin by saying that before the war chemistry, of all the English professions, was the least organized for its own protection and the least appreciated from the national point of view. That undesirable condition has since been substantially modified and improved by two influences. The extent to which military operations in the final stage of the war became dependent on the applications of chemical science has forced upon the public a new sense of the immanence of chemical science throughout practically all industrial processes. On the other side, the ever-rising cost of living, the progressive advances of salary secured by manual workers, and the contrast of their own lot with that of less educated and less responsible classes, have created among working chemists a new sense of class consciousness, and forced upon them the conclusion that relatively to the cost of their education, the responsibility of their work and the vital part that work plays in national industry, their economic condition compares very unfavorably with that of equally or even less educated workers.

CHEMISTS DISCUSS PROBLEMS OF ORGANIZATION

Hitherto the English works chemist has held a sort of half-way position between capital and manual labor. He is not in active opposition or alliance with either interest; nor yet is he sufficiently organized to constitute a definite party to industry himself. Considered as a professional man, he lacks the close and powerful corporate organization which enables the legal and medical professions to safeguard their professional rights and especially to keep out the "quack"; considered as a workman, he hesitates to descend to the trade union basis, and to join with the manual workers whom he directs for the protection of their common interests as employees. So, in a word, the working chemist, economically, hangs suspended halfway between heaven and earth, and he is beginning to look for some more solid and comfortable resting place. Everywhere one turns today chemists are discussing problems of organization. They feel keenly the need and the justice of improved status and improved pay, but so far their views as to how these ends are to be attained are hazy and even conflicting. It may be interesting, therefore, especially in view of the new labor problems arising in the United States, to set out broadly the position as it exists in England today.

To begin with, it should be understood that the English chemist's demand for improved conditions is no piece of mere trade union tactics. The feeling is common to the university chair and the smallest works laboratory. It is based on the conviction that the science of chemistry and all who practice it deserve fuller and more generous recognition all around.

Prof. Henry Louis of the Armstrong College, Newcastle, put the point to me quite frankly some time ago —that when ambitious and capable young men came to him inquiring about chemistry as a profession for life he often felt obliged to warn them of the poor return they might get. John Gray, a managing director of the great firm of **Lever Bros.**, who this year succeeded Prof. Louis as president of the Society of Chemical Industry, told me with equal candor that if we wanted the best chemical brains for the service of industry employers must be more prepared than many are at present to recognize the commercial value of the chemists.

To these testimonies may be added that of Richard B. Pilcher, who has just completed twenty-five years as secretary and twenty as registrar of the Institute of Chemistry. The Institute is essentially a professional and academical body, with powers under its charter to hold examinations and confer degrees. There can be no suspicion of trade unionism about it, yet even the Institute is so much concerned about the economic status of its members that it recently issued a questionnaire on the subject of salaries and working conditions. The results have just been tabulated by Mr. Pilcher, and are shown in the accompanying table.

WORKING CONDITIONS OF BRITISH CHEMISTS						
	Average Salaries, Including Bonus					
Age	Industry	Assistants to Private Practitioners	Government Service	Municipal Service (Whole-time)	Teaching	Average
21–24	£268	...	£256	...	£184	£250
25–29	345	...	327	£284	270	328
30–34	435	£289	346	290	291	390
35–39	546	...	447	360	421	499
40–44	606	484	503	440	400	523
45–49	712	400	545	653	481	592
50–54	883	275	1,290	775	653	789
55–59	609	...	586	531	766	571
60 and over	610	...	840	...	888	747

This table is based on 927 individual returns. As the chemists making the returns are all members of the Institute, it may be assumed that they are all of good academical standing, and that the figures are substantially higher than those that apply to the whole body of works chemists. In addition to the comparatively poor financial pay, the chemist has often to work long overtime without extra remuneration, his annual holiday is usually only a fortnight, and he is generally subject, owing to the confidential nature of his duties, to close restrictive covenants.

In addition to the Institute there are two other bodies organized for the special protection of chemists' interests. The National Association of Industrial Chemists is registered as an ordinary trade union, but it deliberately holds aloof from the political Labor party. The British Association of Chemists, though not for-

mally registered as a trade union, professes similar aims, but here also there is a strong objection to merging the interests of chemists in the Labor movement.

Thus, it will be seen, there are in England three separate bodies all claiming to protect the professional rights of the chemist and all founded on different principles. Among the three there is a certain amount of confusion of thought, and just now the problem is how to find some central organization as wide as chemical industry itself which shall become the recognized custodian of the whole profession. One of the most definite suggestions is that there should be a National Register of Chemists, equivalent to the roll of the Law Society or the Register of Teachers, and that steps should be taken either by charter or act of Parliament to prevent any not admissible to the Register from practicing or accepting appointments as a qualified chemist.

THE "BLACK-COATS" (PROFESSIONAL) CLASS

Quite recently a new and interesting factor has emerged in the shape of a bid from the political Labor party for a compact with the professional class of workers, or "Black-Coats" as they are called. It is no secret that the English Labor party is out to form a Labor Government. Its political power has been growing for some time, but the more intelligent leaders now recognize that manual labor, of which the English Labor party is made up, cannot carry the country unless it has with it the brain workers too.

Recently a conference was held in London with the object of "capturing" the brainworkers for Labor, and the National Association of Industrial Chemists and the British Association of Chemists were invited to join. Both attended, but both declined to merge their identity with the Labor party. For the moment there is no doubt that this represents the general attitude of the British chemical profession. The problem, then, for the future is whether English chemists with other professional bodies will be strong enough to form for themselves what is called a "third party," strong enough to take the necessary action for the protection of their own interests, or whether economic pressure will drive them, as it has driven the National Union of Journalists and other bodies, to throw in their lot unreservedly with the general Labor party.

For the moment, however, strong as the demand among working chemists is for improved economic conditions, there is an equally strong objection to adopting some of the leading doctrines of organized labor. In the first place, in spite of the suave assurances of the more educated labor leaders, labor is essentially and as many fear increasingly a class movement. It refuses to recognize that prosperous national industry is the combined result of co-operative effort and organization. It selfishly assumes that industry and profit are as assured as tomorrow's sunrise, and all that labor has to do is to get as much out of it as possible, while putting as little into it as may be. The Whitley Councils, which have been formed for the joint development by employer and employed of British industry, have already degenerated into cockpits for debates over wages and shorter hours, and instead of developing the co-operative spirit have in many cases merely accentuated the conflict between capital and labor.

Another common fallacy is that labor, by which is meant mere manual labor, produces all the wealth of the country. The part which the capitalist, the organizer, the inventor, the chemical and the civil engineer, and last of all the patient research worker who may at any moment revolutionize existing processes of production by some new discovery—all these count for nothing in the estimate of labor. And it is easy to understand why men who live by their minds' work refuse to subscribe to such a wooden and unimaginative theory of industry.

Another point in labor policy which is viewed with grave suspicion is the Prussianizing of labor. One of the popular cries of a few years ago was the right of every man to work. Now no man must be allowed to work unless he is in the union, and in one particular union which happens for the time being to be the most powerful, and there is a ruthless insistence on the division and subdivision of labor into endless little water-tight compartments, each of which is an exclusive preserve. The effect of the application of this principle to chemical and scientific work generally is delightfully satirized by a well-known consulting chemist, Ivor James:

"The organic chemist would have to cease thinking inorganically; the analyst would not soar researchwise; the professor would surrender his consulting practice, and the lecturer his private tuition; Carius tubes would be the perquisite of the glassworker's union; to tighten or loosen the bolts of an autoclave an engineer —in common parlance, a fitter—would be present, accompanied by his invariable shadow, the mate, bearing a spanner; electro-analysis or electro-reduction would necessitate an electrician—of what variety we do not know, but certainly he would have to be there; and if by chance the unfortunate chemist happened to wash his apparatus, the laboratory steward would complain to the bottlewasher's union, and monsieur would be reprimanded with an intimation that the incident was anathema and must not occur again. The position would be ridiculous, but the ridicule would be just."

CHEMISTS SHUN INTELLECTUAL BONDAGE

But perhaps what the intellectual worker most objects to in modern labor is what is known as the "ca'-canny" policy. In practice this means that the bricklayer, whatever his capacity, must not lay more than a certain number of bricks an hour; that the compositor must not set more than a certain number of lines; that the barber must not shave more than the prescribed number of customers, and so on all through industry. This is bad enough applied to the purely mechanical trades, for it cuts down the producing capacity of the best artisan to the pace of the slowest and least efficient, and kills the honest workman's personal zest in his work. It is waste of time for the apprentice to attend technical classes and master the art or science of his craft if when he becomes a full-grown workman his union encases him in the iron fetters of a standardized output. But applied to science, to research, to every form of intellectual work, it is a deliberate sterilizing of potential brain power, a suppression of personal initiative, a bondage of all the forces of thought and energy that make for human progress.

Little wonder, then, that English chemists, eager as they are to see an improvement in their conditions and prospects, decline open eyed to enter into such an intellectual bondage, and prefer to work out their own salvation on more liberal and humane lines. That is the problem to which they are now addressing themselves, and developments of great interest may be expected in the next few years.

Aluminum Rolling-Mill Practice—III
Ingot Heating and Mill Calculations

Specifications and Some of the Uses for Sheet Aluminum Are Noted, Followed by a Discussion of Furnaces for Heating Ingots Preparatory to Slabbing — Tables and Examples of Calculations Are Given Whereby Individual Orders May Be Rolled With Minimum Allowance for Scrap*

By ROBERT J. ANDERSON AND MARSHALL B. ANDERSON

MANY applications of aluminum sheet have been made, and uses for the metal in this form have increased rapidly in recent years. Aluminum and 1.5 per cent manganese-aluminum alloy sheets are used very largely in motor-car body construction, while substantially pure aluminum in the form of sheets finds considerable employment for fabricating cooking utensils, for building vats and vessels, for aircraft parts, and for various small stampings. Sheet aluminum is also fabricated for motor-car headlights, surgeons' splints. artificial limbs, and soldiers' canteens and field utensils; while in the form of rolled and annealed sheets, the metal is used in printing and lithography. Many other uses are on record, but the main outlet for the metal in sheet form is for motor cars, cooking utensils, vats and tanks, and for small stampings.

In addition to substantially pure aluminum, some of its light alloys, notably duralumin, are rolled into sheets for purposes where greater strength is required than can be obtained with the metal itself. Some of the rolled and annealed light alloys have as great ultimate strength as hard-rolled pure aluminum. The progress made with regard to rolled light alloys of aluminum was marked in connection with the late war, and this will result in further applications of the metal. An alloy containing about 1.5 per cent manganese, whose production has already been described in the early part of this article, is also rolled for so-called hard sheets, and it is employed considerably in motor-car body construction.

Very little scientific work has been performed in the rolling of aluminum, nor is much information available with regard to the rolling of its light alloys for the manufacture of sheets. Some information in connection with rolling rods in the light alloys is on record. The corrosion of aluminum sheets and cooking utensils, as well as of some of the rolled alloys, including duralumin, has been investigated at considerable length, and a fair amount of data is on hand in regard to that matter.

SPECIFICATIONS FOR SHEET

As to specifications for sheet aluminum, few are available. Specifications for substantially pure aluminum sheet, both cold rolled and annealed, and for duralumin are given in Tables VI and VII. Three of these specifications are in condensed form of the complete specifications of the Bureau of Aircraft Production, while the fourth is a provisional specification of the British Admiralty Air Department; new specifications are now being prepared by the Bureau (now the Engineering Division, Aircraft Service), and those given in the tables may be superseded by others in the

future. Specifications for sheet aluminum, particularly for deep drawing stock, have never been worked out satisfactorily, to the writers' knowledge. In the case of deep drawing stock, tensile tests and hardness values are practically useless criteria in attempting to determine the "drawability"' of a sheet. The only test

TABLE VI. SPECIFICATIONS FOR ALUMINUM SHEET
Bureau of Aircraft Production Specification for Soft Annealed Sheet Aluminum

The following grades of aluminum, conforming to the requirements of the specification for ingot aluminum, may be ordered to this specification:

Grade	Al, per Cent Min.
Standard No. 1	99.0
Standard No. 2	98.0

Test specimens cut in any direction from sheets must have the following physical properties:

American Wire Gage, B. & S. Nos.	Thickness In.	Thickness Mm.	Minimum Tensile Strength Lb. per Sq. In.	Minimum Tensile Strength Kg. per Sq. Cm.	Elongation in 2 In., per Cent (Min.)
10 to 16, incl......	0.102 to 0.051	2.59 to 1.30	12,000	844	30.0
18 to 22, incl......	0.040 to 0.025	1.02 to 0.64	12,000	844	20.0
24 to 26, incl......	0.020 to 0.016	0.51 to 0.41	12,000	844	10.0

Specification for Hard-Rolled Sheet Aluminum

The grades of aluminum may be ordered as above.
Test specimens cut in any direction from sheets must have the following physical properties:

American Wire Gage, B. & S. Nos.	Thickness In.	Thickness Mm.	Minimum Tensile Strength Lb. per Sq.In.	Minimum Tensile Strength Kg. per Sq.Cm.	Elongation in 2 In., per Cent (Min.)
10 to 26, incl	0.102 to 0.016	2.59 to 0.41	22,000	1,547	2.0

TABLE VII. SPECIFICATION FOR DURALUMIN SHEET
Bureau of Aircraft Production Specification for Aluminum-Alloy Sheet

Sheet under this specification shall have a maximum specific gravity of 2.85 and shall be made from Standard No. 1 aluminum ingot.
Test specimens cut in any direction from the sheets must have the following physical properties: .

Temper No. 1

Tensile strength (min.), lb. per sq.in................................	55,000
Kg. per sq.cm...........................	3,866
Yield point (min.), lb. per sq.in...................................	25,000
Kg. per sq.cm................................	1,758
Elongation (min.) in 2 in., per cent.............................	15

Temper No. 2

Tensile strength (min.), lb. per sq.in................................	50,000
Kg. per sq.cm...............................	3,515
Yield point (min.), lb. per sq.in...................................	25,000
Kg. per sq.cm................................	1,758
Elongation (min.) in 2 in., per cent.............................	20

British Admiralty Air Department Specification for Duralumin Sheets

The sheets are to be made of duralumin alloy of specific gravity not exceeding 2.85.
Strips cut from the sheets lengthwise are to show when tested in tension not less than—

Thickness of Sheets	Tensile Strength Tons per Sq.In.	Kg. per Sq.Cm.	Elongation, per Cent on 2 In.
0.05 in. (1.27 mm.) and above..............	25	3,515	15
Below 0.05 in. (1.27 mm.)..............	25	3,515	10

*Anderson, Robert J., "Erichsen Tests on Aluminum Sheet," *Iron Age*, vol. 101, 1918, pp. 950-951; "The Testing of Sheet Aluminum," *Iron Age*, vol. 102, 1918, pp. 148-149.

*For Parts I and II see CHEM. & MET. ENG., vol. 22, Nos. 11 and 12, March 17 and 24, 1920, pp. 489 and 545.

which can give any definite indication of how sheets will perform in the draw press is the cupping test (Erichsen). This test is of great value for the purpose mentioned and can be rapidly applied. The writers are not aware that this test has been insisted upon to any extent as yet for deep drawing stock, but users of sheet for this purpose will do well to investigate its merits.

HEATING INGOTS FOR ROLLING

The statement has already been made that aluminum ingots are either rolled directly from the molds after solidification or they are preheated to a definite temperature in ingot-heating furnaces before rolling. We will deal first with the preheating of ingots for rolling.

In order to bring ingots to the desired rolling temperature, they are charged into an ingot-heating furnace and raised to about 425 to 450 deg. C. Rolling temperatures may vary in different works, and may be higher or lower in case light alloys are rolled. The ingot-heating furnace may be either gas- or oil-fired, or it may be heated electrically. A typical furnace is a gas-fired, five-track furnace. In case gas is used for firing, it is advisable to have oil-burning equipment provided, and *vice versa.*

The tracks in an ingot-heating furnace may be made of two ordinary steel rails placed about 1 ft. apart and fastened to the furnace floor. Ingots are pushed from the charging end to the front of the furnace by an ingot pusher, consisting of a ram, with a slow rate of motion, actuated by motor drive. To charge an empty furnace, an ingot is placed upon one of the tracks at the rear of the furnace, the ingot pusher is brought into position, and the ram then pushes the ingot along the track and toward the front of the furnace. In the present case, the ram does not travel far, i.e., it cannot push an ingot from the charging end to the discharge end, but it has an effective working distance of up to 24 in. (0.6 m.) or thereabouts. Hence, tracks are filled by pushing forward a number of ingots together.

Ingot-heating furnaces may be built in various sizes, but a typical furnace will have inside measurements as follows: 35 ft. long, 10 ft. wide, and 4 ft. high (10.7 x 3 x 1.2 m.). Double doors are hung on pulleys with balance weights at each end of the furnace and temperatures are taken by means of three pyrometers placed through the roof. An average furnace, with five tracks holding thirty-three ingots 12 in. (30 cm.) wide, contains 165 ingots when filled.

HEATING INGOTS TWO-HIGH

Attempts have been made to double the capacity of such a furnace by charging ingots two-high, but this is a questionable practice unless the furnace has been expressly designed for that purpose, since heating two-high in an improperly designed furnace leads to higher scrap losses at the hot mill and introduces other difficulties. In some furnaces, when running ingots two-high, it is necessary to overheat the top rows of ingots in order to raise the bottom rows to the rolling temperature. Aluminum becomes increasingly hot short at higher temperatures, and this leads to breakage of ingots, particularly on the first pass. Overheated ingots, i.e., those rolled at too high temperatures, usually result in "fire-cracked" slabs. Furthermore, the higher temperatures of the ingots cause higher roll temperatures, and this results in more roll breakages. Two-high heating of ingots will usually result in

non-uniformity of ingot, and consequently of rolling. temperatures, which is to be strictly guarded against. If the metal is rolled too hot it is too "tender"; if rolled too cold, it takes too long to break the ingots down. Rolling temperatures in relation to the amount of reduction have not been worked out, but 425 to 450 deg. C. at the furnace is fairly satisfactory for most breakdown operations.

When a track is full, and the hot mill is running, an ingot will be withdrawn from the front of the furnace for rolling; the track will be kept full of ingots by immediately placing a cold ingot on the track at the charging end and pushing up the line of ingots. In actual operation, the ingot-heating furnace is continually kept full of ingots by charging a cold ingot after withdrawing a hot one for rolling. Ingots are withdrawn from the various tracks in rotation so that each remains in the furnace for about the same length of time. Thus, in a five-track furnace, which may hold thirty-three 12-in. ingots per track, the usual method is to push out and roll the thirty-three hot ingots from track 1, filling up with cold ingots as rolling proceeds. Ingots are then rolled from track 2, then from track 3, and so on. By the time the ingots on track 5 have been rolled, those on track 1 are at the rolling temperature. Thus the operation proceeds continuously except in case of breakdown or shutdown at the hot mill. Breakdowns of the ingot-heating furnace itself are rare, since there is practically nothing which can get out of order. The only difficulties at the furnace will come in connection with the fuel supply and the method of firing. When a cold furnace is started, it may require, with gas or oil firing, from 10 to 12 hr. to raise the ingots to the rolling temperature. After the first batch has been rolled, succeeding charges will be in the furnace for about 6 hr.

Furnaces have double doors at both ends, and it is imperative to keep the doors shut at all times except when necessary to charge or withdraw ingots; otherwise, the ingots in the furnace may be unduly cooled by draughts. This is an important point in cold weather if the mill building is not tight. In a five-track furnace with double doors, it is necessary to open both doors at either end when withdrawing or charging ingots on the middle track. A better design would consist of a six-track furnace so arranged that each door would serve three tracks.

When an ingot is to be broken down in the hot mill for the production of slabs, it is withdrawn from the furnace at a temperature of 425 to 450 deg. C., and immediately conveyed on a truck to the mill and rolled. From 30 sec. to 2 min. may elapse prior to the first pass, the elapsed time depending upon the distance from the furnace to the mill and also upon the behavior of the previously rolled ingot. Thus, the hot-mill roller may consider the metal to be too hot, and he will accordingly hold the ingot so as to allow it to cool somewhat before rolling. This appears to be a matter which varies with individual rollers; it may have some bearing upon practical hot-mill operation, but, on the other hand, it may be based upon the vagaries of different rollers.

BREAKING DOWN WITHOUT PREHEATING

In the foregoing, the statement has been made that aluminum ingots are also rolled without preheating in a furnace, by sending them to the hot mill directly from the molds. In this practice about 5 min. are

allowed for cooling to the desired rolling temperature. It is a mistake to roll aluminum in this way. The most self-evident reasons which should deter mill superintendents from so rolling aluminum are these: (1) There is no temperature control; (2) the temperatures are usually unknown; (3) there are wide variations in the temperatures of succeeding ingots; and (4) if a breakdown occurs at the hot mill, production is stopped not only there but at the melting end. Moreover, there is a distinctly greater percentage of defective slabs produced at the hot mill when rolling directly from the molds than when ingots are preheated to a definite temperature. Actual temperature measurements of ingots rolled directly from the molds have been taken at the hot mill, and variations from 370 to 625 deg. C. have been observed. Such variations are altogether too wide. At the lower temperatures, it takes too long to break down an ingot because more passes must be

TABLE VIII. THICKNESSES TO WHICH INGOTS ARE BROKEN DOWN HOT FOR VARIOUS SIZES AND GAGES OF ALUMINUM SHEETS

Finished Gage to Be	Finished Width to Be, In.	Finished Length to Be, In.	Should Be Broken Down Hot to, In. Thick	Remarks
1 to 4	....	....	0.500	Finished from the hot mill slab
5 to 7	.. ...	....	0.300	Finished from the hot mill slab
8 to 9	....	....	0.250	Finished from the hot mill slab
10 to 11	....	....	0.200	Finished from the hot mill slab
12 to 13	....	....	0.300	Slabbed cold
14	40	124	0.300	Slabbed cold
14	41 to 70	125 to 160	0.400	Slabbed cold
15	....	....	0.250	Slabbed cold
16	40	100	0.250	Slabbed cold
16	48	124	0.300	Slabbed cold
16	60	160	0.400	Slabbed cold
17 to 25	....	....	0.250	Slabbed cold
26 to 40	....	....	0.200	Slabbed cold

(1 in. = 2.54 cm.)

...... indicate practically any length or width.

In general, the hot-mill slabs are cold-slabbed to one-half the original thickness. Gages from 1 to 11, inclusive, are not slabbed.

Table XI gives relation between gages and thickness.

given, as the metal is not so readily worked at lower temperatures. At the higher temperatures the metal is hot short and breaks readily under pressure.

Rolling temperatures are important, and it is a difficult matter to maintain anything like uniformity of temperature in succeeding ingots where they are rolled directly from the molds. In case of emergency, say where a breakdown takes place at the ingot-heating furnace, or there is a gas shortage or difficulty with oil circulation, it might be desirable to roll ingots directly from the molds and thus avoid entirely tieing up production on the hot-mill. But, in general, this method is never the best for hot-mill practice.

CALCULATIONS FOR SHEETS

Reasonably exact calculations are required in determining the size and number of ingots to be rolled for a given order of sheets. Sheet orders may be given in different ways; for example, the customer may specify a certain number of sheets of definite gage and size, or, on the other hand, a certain number of pounds of sheets. Orders may, therefore, read as follows: 100 sheets, 16-gage, 40 by 96 in.; or 1,000 lb. of sheets, 18-gage, 44 by 112 in. Sizes in demand vary widely according to market requirements.

Tables VIII, IX, X, XI, XII, XIII and XIV will be found useful in calculating sheet orders. Table VIII gives the thicknesses to which ingots are broken down hot for sheets of various gages and sizes; the figures

TABLE IX. THICKNESSES TO WHICH HOT-MILL SLABS ARE COLD-SLABBED FOR VARIOUS GAGES AND SIZES OF ALUMINUM SHEETS

Finished Gage To Be	Finished Width to Be. In.	Finished Length to Be. In.	Should Be Cold Slabbed to, In.	Remarks
1 to 11	....	....	Not slabbed	Finished from the hot-mill slabs
12 to 13	....	....	0.150	Roughed
14	....	50 to 124	0.150	Roughed
14	....	130 to 164	0.200	Roughed
16	....	110 to 124	0.150	Roughed
16	....	134 to 164	0.200	Roughed
17 to 25	....	....	0.125	Roughed
26 to 40	....	....	0.095	Roughed

(1 in. = 2.54 cm.)

...... indicate practically any length or width.

Table XI gives relation between gages and thickness.

TABLE X. SCRAP ALLOWANCES FOR FINISH SHEARING ON ALUMINUM SHEETS

Finished Gage to Be	Allowance for Side Shearing, In.	Allowance for End Shearing, In.
7 and heavier	2.0	6.0 to 7.0
8 to 10	2.0	8.0 to 10.0
11 to 13	2.0	11.0 to 13.0
14 to 18	2.0	14.0 to 18.0
19 to 20	4.0	19.0 to 20.0
21 to 23	5.0	21.0 to 23.0
24 to 26	6.0	24.0 to 26.0
27 to 30	7.0	27.0 to 30.0

(1 in. = 2.54 cm.)

The figures given include both sides and both ends; for example, in the case of a 16-gage sheet, 1 in. is allowed for shearing on each side, and 8 in. on each end.

Larger end and side scrap allowances are made for the lighter gages, because of the greater tendency of these gages to crack during rolling.

Table XI gives relation between gages and thickness.

TABLE XI. WEIGHTS OF ALUMINUM SHEETS AND SLABS IN VARIOUS GAGES AND THICKNESSES

Sheet Gage, A.W.G.	Thickness In.	Thickness Mm.	Wt., Lb. per Sq.Ft.	Kg. per Sq.M.
0000	0.4600	11.68	6.406	31.28
000	0.4096	10.40	5.704	27.85
00	0.3648	9.16	5.080	24.80
0	0.3248	8.25	4.524	22.09
1	0.2893	7.35	4.029	19.67
2	0.2576	6.54	3.588	17.52
3	0.2294	5.83	3.195	15.60
4	0.2043	5.19	2.845	13.89
5	0.1819	4.62	2.534	12.37
6	0.1620	4.11	2.256	11.01
7	0.1442	3.66	2.009	9.809
8	0.1284	3.26	1.789	8.735
9	0.1144	2.91	1.594	7.782
10	0.1018	2.59	1.418	6.923
11	0.0907	2.30	1.264	6.171
12	0.0808	2.05	1.126	5.498
13	0.0719	1.83	1.002	4.892
14	0.0640	1.63	0.892	4.355
15	0.0570	1.45	0.796	3.886
16	0.0508	1.29	0.707	3.452
17	0.0452	1.15	0.630	3.076
18	0.0403	1.02	0.561	2.739
19	0.0358	0.91	0.499	2.436
20	0.0319	0.81	0.445	2.173
21	0.0284	0.72	0.396	1.933
22	0.0253	0.64	0.353	1.723
23	0.0225	0.57	0.314	1.533
24	0.0201	0.51	0.279	1.362
25	0.0179	0.45	0.249	1.216
26	0.0159	0.40	0.221	1.079
27	0.0141	0.36	0.197	0.962
28	0.0126	0.32	0.176	0.859
29	0.0112	0.28	0.156	0.762
30	0.0100	0.25	0.139	0.679
31	0.0089	0.23	0.124	0.605
32	0.0079	0.20	0.110	0.537
33	0.0070	0.18	0.098	0.478
34	0.0063	0.16	0.087	0.425
35	0.0056	0.14	0.078	0.381
36	0.0050	0.13	0.069	0.337
37	0.0044	0.11	0.062	0.303
38	0.0039	0.10	0.055	0.269
39	0.0035	0.09	0.049	0.239
40	0.0031	0.08	0.043	0.210

Slabs

Thickness In.	Mm.	Wt., Lb. per Sq.Ft.	Kg. per Sq.M.
1/16	1.59	0.869	4.25
1/8	3.18	1.739	8.49
3/16	4.76	2.609	12.74
1/4	6.35	3.479	16.99
5/16	7.94	4.348	21.23
3/8	9.53	5.218	25.48
7/16	11.11	6.088	29.72
1/2	12.70	6.958	33.97
9/16	14.29	7.827	38.21
5/8	15.88	8.697	42.46
11/16	17.46	9.567	46.70
3/4	19.05	10.435	50.95
13/16	20.64	11.306	55.20
7/8	22.22	12.175	59.44
15/16	23.81	13.045	63.69
1	25.40	13.914	67.93

TABLE XII. SCALE FOR SLAB CUTS

Required Length of Finished Sheet

Length of Cuts Made on Shearing, in Inches

A.W.G. Thickness	50	54	60	64	70	72	74	80	84	90	94	96	98	100	110	112	114	116	120	124	130	134	136	138	140	142	144	148	150	152	154	156	158	160	164
1	29	32	35	38	41	42	44	47	50	53	55	57	58	59	64	66	67	69	70	73	76	79	80	81	83	84	85	87	88	90	91	92	93	94	97
2	27	29	32	34	37	38	39	42	44	48	50	51	52	53	58	59	60	61	64	66	69	71	72	73	74	75	76	77	78	79	80	81	82	83	87
3	22	24	26	28	30	31	32	35	37	39	40	41	42	43	48	49	49	50	52	54	56	58	59	60	61	62	63	64	65	66	67	68	69	70	71
4	21	23	25	27	29	30	31	34	35	38	39	40	41	42	46	47	48	49	50	52	54	56	57	58	59	60	61	62	63	64	65	66	67	68	69
5	31	34	37	40	42	45	46	50	53	56	58	60	62	63	69	70	71	73	75	78	81	84	85	87	88	89	90	93	94	95	97	98	99	100	103
6	28	30	33	36	39	40	41	44	47	50	52	53	54	55	61	62	63	64	66	69	72	74	75	77	78	79	80	82	83	84	85	87	88	89	91
7	24	25	29	30	33	34	35	38	40	43	44	45	46	47	52	53	54	55	57	59	62	64	65	66	67	68	69	70	71	72	73	74	75	76	78
8	26	28	31	34	37	38	39	43	45	48	50	51	52	53	59	60	61	62	64	66	69	71	72	73	74	75	76	77	78	79	80	81	82	83	84
9	23	25	27	29	32	33	34	36	38	41	43	44	45	46	50	51	52	53	54	56	59	61	62	63	64	65	66	67	68	69	70	71	72	73	75
10	26	28	31	34	37	38	39	43	45	48	50	51	52	53	59	60	61	62	64	66	69	71	72	73	74	75	76	77	78	79	80	81	82	83	86
11	23	25	27	29	32	33	34	36	38	41	43	44	45	46	50	51	52	53	55	56	59	61	62	63	64	65	66	67	68	69	70	71	72	73	75
12	26	28	31	34	37	38	39	43	45	48	50	51	52	53	59	60	61	62	64	66	69	71	72	73	74	75	76	77	78	79	80	81	82	83	86
13	24	26	29	31	34	35	36	38	40	43	45	46	47	48	53	54	55	56	57	59	62	64	65	66	67	68	69	70	71	72	73	74	75	76	78
14	22	24	26	28	30	31	32	35	37	39	41	42	43	44	48	49	50	51	52	54	42	43	44	45	46	.47	48	49	50	51	52	53	54	53	54
15	23	25	27	29	32	33	34	36	38	40	43	44	45	46	50	51	52	53	55	56	59	61	62	63	64	65	66	67	68	69	70	71	72	73	75
16	20	21	24	26	28	29	30	32	34	36	38	39	40	41	33	34	34	35	35	37	37	37	38	38	39	39	40	40	41						
17	18	19	22	23	25	26	27	29	30	32	34	35	35	36	39	40	41	42	43																
18	16	17	19	21	23	24	24	26	27	29	31	31	32	33																					
19	14	15	17	18	20	20	21	23	24	25	27	27	28	28																					
20	13	14	15	16	18	18	19	20	21	23	24	24	25	25																					
21	11	12	14	15	16	16	17	18	20	21	22	22	23																						
22	10	11	12	13	14	15	15	16	17	18	19	20	20	20																					
23	9	10	10	11	13	13	13	14	15	16																									
24	8	9	10	11	12	12	12	13	14	15																									
25	7	8	9	9	10	10	11	11	12	13																									
26	8	9	10	11	12	12	12	13	14	15																									
27	8	8	9	10	11	11	11	12	12	14																									
28	7	7	8	9	10	10	10	11	11	13																									
29	6	6	7	8	8	9	9	10	10																										
30	6	6	7	7	8	8	8	9	9	10																									
31	5	5	5	6	6	6	7	7	7	8																									
32	4	5	5	5	6	6	6	7	7	7																									
33	4	5	5	5	6	6	6	7	7	7																									
34	4	4	4	4	5	5	5	5	5	5																									
35	3	3	4	4	4	4	4	5	5	5																									
36	3	3	4	4	4	4	4	5	5	5																									
37	3	3	3	3	3	4	4	4	4	4																									
38	2	2	2	2	3	3	3	3	3	3																									
39	2	2	2	2	3	3	3	3	3	3																									
40	2	2	2	2	3	3	3	3	3	3																									

Notes to Table:

1. Thickness to which ingots are broken down hot for various sizes and gage of sheets are given in Table VIII.

2. Thickness to which hot-mill slabs are cold slabbed are given in Table IX.

3. Relation between gage and thickness in Table XI.

1 in. = 2.54 cm.

TABLE XIII. SLAB LENGTHS AND WIDTHS FOR 4 X 12 X 17-INCH INGOTS

	Area, 6,724 Sq.In. Thickness, 0.095 In.		Area, 6,419 Sq.In. Thickness, 0.100 In.		Area, 5,183 Sq.In. Thickness, 0.125 In.		Area, 4,485 Sq.In. Thickness, 0.150 In.		Area, 3,364 Sq.In. Thickness, 0.200 In.		Area, 2,724 Sq.In. Thickness, 0.250 In.		Area, 2,270 Sq.In. Thickness, 0.300 In.		Area, 1,816 Sq.In. Thickness, 0.375 In.	
Width, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.	Width, In.	Length, In.
12	12	560	12	534	12	427	12	373	12	280	12	227	12	197	12	151
13	13	517	13	493	13	394	13	345	13	258	13	209	13	174	13	139
14	14	480	14	458	14	366	14	320	14	240	14	194	14	162	14	129
15	15	448	15	427	15	342	15	299	15	224	15	181	15	151	15	121
16	16	420	16	401	16	320	16	280	16	210	16	170	16	141	16	113
17	17	395	17	377	17	301	17	263	17	197	17	160	17	133	17	106
18	18	373	18	356	18	285	18	249	18	186	18	151	18	126	18	100
19	19	353	19	337	19	270	19	236	19	177	19	143	19	119	19	95
20	20	336	20	320	20	256	20	224	20	168	20	136	20	113	20	90
21	21	320	21	305	21	244	21	213	21	160	21	129	21	108	21	86
22	22	305	22	291	22	233	22	203	22	152	22	123	22	103	22	82
23	23	292	23	279	23	223	23	195	23	146	23	118	23	98	23	78
24	24	280	24	267	24	213	24	186	24	140	24	114	24	94	24	75
25	25	268	25	256	25	205	25	179	25	134	25	109	25	90	25	72
26	26	258	26	246	26	197	26	172	26	129	26	104	26	87	26	69
27	27	249	27	237	27	190	27	166	27	124	27	100	27	84	27	67
28	28	240	28	229	28	183	28	160	28	120	28	97	28	81	28	64
29	29	231	29	221	29	177	29	154	29	116	29	94	29	78	29	62
30	30	224	30	213	30	171	30	149	30	112	30	90	30	75	30	60
31	31	216	31	207	31	165	31	144	31	108	31	88	31	73	31	58
32	32	210	32	200	32	160	32	140	32	105	32	85	32	70	32	56
33	33	203	33	194	33	155	33	135	,33	101	33	82	33	68	33	55
34	34	197	34	188	34	150	34	131	34	98	34	80	34	66	34	53
35	35	192	35	183	35	146	35	128	35	96	35	77	35	64	35	51
36	36	186	36	178	36	142	36	124	36	93	36	75	36	63	36	50
37	37	181	37	173	37	138	37	121	37	90	37	73	37	61	37	49
38	38	176	38	168	38	135	38	118	38	88	38	71	38	59	38	48
39	39	172	39	164	39	131	39	115	39	86	39	69	39	58	39	46
40	40	168	40	160	40	128	40	112	40	84	40	68	40	56	40	45
41	41	164	41	156	41	125	41	109	41	82	41	66	41	55	41	44
42	42	160	42	152	42	122	42	106	42	80	42	64	42	54	42	43
43	43	156	43	149	43	119	43	104	43	78	43	63	43	52	43	42
44	44	152	44	145	44	116	44	101	44	76	44	61	44	51	44	41
45	45	149	45	142	45	114	45	99	45	74	45	60	45	50	45	40
46	46	146	46	139	46	111	46	97	46	73	46	59	46	49	46	39
47	47	143	47	136	47	109	47	95	47	71	47	57	47	48	47	38
48	48	140	48	133	48	106	48	93	48	70	48	56	48	47	48	37
49	49	137	49	131	49	104	49	91	49	68	49	55	49	46	49	37
50	50	134	50	128	50	102	50	89	50	67	50	55	50	45	50	36
51	51	131	51	125	51	100	51	87	51	65	51	54	51	44	51	35
52	52	129	52	123	52	98	52	86	52	64	52	53	52	43	52	34
53	53	126	53	121	53	96	53	84	53	63	53	52	53	42	53	34
54	54	124	54	118	54	95	54	83	54	62	54	51	54	42	54	33
55	55	122	55	116	55	93	55	81	55	61	55	50	55	41	55	33
56	56	120	56	114	56	91	56	80	56	60	56	49	56	40	56	32
57	57	117	57	112	57	90	57	78	57	59	57	48	57	39	57	31
58	58	115	58	110	58	88	58	77	58	58	58	47	58	38	58	31
59	59	113	59	108	59	87	59	76	59	57	59	46	59	37	59	30
60	60	112	60	106	60	85	60	74	60	56	60	45	60	36	60	30

The area of any slab at the thickness indicated is the product of the length times the width.
This table is used in conjunction with Table XII.
1 in. = 2.54 cm.

indicate the ordinary sizes in the gages mentioned, but the other possible variations are many indeed. The figures are applicable to ingots of any size; the size of ingot chosen will depend upon the finished dimensions of the sheets, and such ingots will be rolled as will permit of small scrap losses on shearing. Table IX shows the thicknesses to which hot-mill slabs are cold-slabbed before roughing for various gages and sizes of sheets. Table X gives the usual scrap allowances for finish shearing on aluminum sheets. Figures for shearing must be available so as to calculate the sizes of the hot-mill slabs. Table XI gives figures for the weight per sq.ft. and the thickness of various gages in aluminum sheets and in different thicknesses of slabs. Table XII is a scale for cuts on hot-mill slabs; the tabular quantities are the length which should be cut from a slab in order to roll to a definite length in the finished sheet. Table XII is to be used in conjunction with Table XIII; the latter gives the lengths and widths possible in hot-mill slabs rolled from 4 x 12 x 17 in. (13 x 30 x 43 cm.) ingots to various thicknesses. Table XIV shows the approximate number of sheets to be rolled per pack for various gages; lengths and widths do not determine the number of sheets to be rolled in pack, as will be explained at length in later paragraphs. The use of these tables will be explained at length with practical examples.

With the exceptions given below, all ingots broken down in the hot mill are subsequently cold slabbed to 0.125 in. (3.8 mm.) thick before roughing and finishing. The exceptions are these:

(1) Sheets to finish heavier than 12-gage and any length are not slabbed, but are hot rolled to thicknesses as follows:

Finished Gage		Hot Rolled to
1 to 4	....	0.500 inch (12.7 mm.)
5 to 7	....	0.300 inch (7.6 mm.)
8 to 9	....	0.250 inch (6.4 mm.)
10 to 11	....	0.200 inch (5.1 mm.)

(2) Sheets to finish 12- and 13-gage and any length are slabbed to 0.150 in. (3.8 mm.).

(3) Sheets to finish 14-gage and 50 to 124 in. (1.3 to 3.1 m.) long are slabbed to 0.150 in. (3.8 mm.).

(4) Sheets to finish 14-gage and 130 to 164 in. (3.3 to 4.2 m.) long are slabbed to 0.200 in. (5.1 mm.).

(5) Sheets to finish 16-gage and 110 to 124 in. (2.8 to 3.1 m.) long are slabbed to 0.150 in. (3.8 mm.).

(6) Sheets to finish 16-gage and 134 to 164 in. (3.4 to 4.2 m.) long are slabbed to 0.200 in. (5.1 mm.).

(7) Sheets to finish 26-gage to 40-gage, inclusive, and any length are slabbed to 0.095 in. (2.4 mm.).

Usually, all sheets to finish lighter than 11-gage are hot-rolled to twice the cold slab thickness; that is, the hot slab should be of such thickness that it may be reduced one-half on cold slabbing and still leave sufficient thickness for roughing and finishing. The figures given in the foregoing and in the tables are largely applicable in a general way, but other combinations may be as suitable. The use of the tables in connection with calculations and the actual methods of calculating orders may conveniently be explained by means of a few examples.

Example 1.—Suppose an order for 500 lb. of 20-gage, 30 x 40 in. dead soft sheet comes into the mill. On 20-gage, sheets of this size will be run two in a pack. The scrap allowances for shearing are 4 in. for side scrap and 20 in. for end scrap, from Table X. In breaking down 4 x 12 x 17 ingots for 20-gage sheet, the ingots

will be hot rolled to ¼ in., and then cold slabbed to ⅛ in. (Tables VIII and XII and above explanation). The thickness of 20-gage sheet is taken as 0.031 in. The calculations are:

0.125 ÷ 0.031 = 4, a factor.
60 in. = finished length plus scrap allowance.
60 ÷ 4 = 15, the length of cuts to be made on the slab.
150 in. = length of a 4 x 12 x 17 in. ingot after breaking down to a thickness of 0.125 and a width of 34 in. (Table XIII.)
150 ÷ 15 = 10, the number of pieces which can be cut from a cold slab, rolled as indicated.
30 x 40 in. is the size of sheets wanted.
30 x 40 = 1,200 sq.in., or 12,000 sq.in. of 20-gage sheet can be obtained from one 4 x 12 x 17 in. ingot.
12,000 ÷ 144 = 83 sq.ft. of sheet.
20-gage sheet weighs 0.445 lb. per sq.ft.
0.445 × 83 = 38 lb. of finished sheet from one ingot.
Figuring 10 per cent of total order for scrap, then 500 + 50 = 550 lb.
550 ÷ 38 = 14+ ingots.
Then, 15 ingots, 4 x 12 x 17 in., should be run for this order.

Example 2.—Consider an order for 500 lb. of 20-gage, 7.5-in. diameter circles, strip-roll metal. This order will be rolled from 4 x 12 x 17 in. ingots. It would be impractical to attempt to roll a hot-mill slab to a width of about 7.5 in. from such ingots, and therefore it will be advisable to roll to about twice this width. The circle shearing allowance on a 7.5-in. circle will be 1 in. Hence,

7.5 + 1 = 8.5 in.
8.5 × 2 = 17 in.
Add 1 in. for slab shearing.
17 + 1 = 18 in., the width to which the hot-mill slabs should be rolled.
Metal for 20-gage strip rolled sheet will be hot rolled to 0.375.
0.375 ÷ 0.031 = 12, a factor.
100 in. = length obtained from a 4 x 12 x 17 in. ingot after breaking down to a thickness of 0.375 in. and a width of 18 in. (Table XIII.)
The order calls for 7.5-in. diameter circles.
$\pi r^2 = \pi \times 3.75^2 = 44.18$ sq.in.
100 × 12 = 1,200.
1,200 ÷ 8.5 = 141, the number of circles in half the width of a slab.
141 × 2 = 282, the number of circles which can be obtained from one ingot.
44.18 × 282 = 12,458.8 sq.in. of circles from one ingot.
12,458.8 ÷ 144 = 86.5 sq.ft. of circles.
20-gage sheet weighs 0.445 lb. per sq.ft.
0.445 × 86.5 = 48.5 lb. of circles from one ingot.
Figuring 10 per cent of total order for scrap, then 500 + 50 = 550 lb.
550 ÷ 48.5 = 11+ ingots.
Then, 12 ingots, 4 x 12 x 17 in., should be run for this order.

Example 3—This example will explain in detail the use of Tables XII and XIII in calculations for sheets. Consider an order calling for 1,000 lb. 16-gage, 40 x 144 in., intermediate sheets, to scleroscope 13 (regular hammer). The thickness of 16-gage is 0.0508 in. Scrap allowances on sheets of the size mentioned will be 2 in. for side scrap and 16 in. for end scrap. Hot-mill slabs for these sheets will be rolled to 0.300 and cold slabbed to 0.150, and the hot slabs should measure 42 x 160 in. The calculations are:

0.150 ÷ 0.0508 = 3, a factor.
160 in. = length of the cold slab.
160 ÷ 3 = 53 in., the length of cuts to be made on the cold slab.
Referring now to Table XIII, and looking in the cold slab thickness column headed 0.150 in., run down the column to 42 (the width of the slab); the number opposite is 106.
106 in. = length obtainable from a 4 x 12 x 17 in. ingot after breaking down to 0.150 x 42.
106 ÷ 53 = 2, the number of pieces which can be cut from a cold slab, rolled as indicated.
40 × 144 in. is the size of sheets wanted.
40 × 144 = 5,760 sq.in., or 11,520 sq.in. of 16-gage sheet can be obtained from one 4 x 12 x 17 in. ingot.
11,520 ÷ 144 = 80 sq.ft. of sheet.
16-gage sheet weighs 0.7078 lb. per sq.ft.
0.7078 × 80 = 56.6 lb. of finished sheet from one ingot.
Figuring 10 per cent of total order for scrap, then 1,000 + 100 = 1,100 lb.
1,100 ÷ 56 = 19+ ingots.
20 ingots, 4 x 12 x 17 in., should be run for this order.

Example 4—Later on it will be said that scrap losses may assume unreasonable proportions because of miscalculations with the size ingots to be rolled. As stated previously, the size ingots to be rolled depends upon the size of sheets to be made, and it is desirable to choose such ingots as will give small scrap losses in shearing, i.e., for example, the ingots should cut into several pieces without much scrap. A practical example will demonstrate the principles involved. Suppose an

order for 1,000 lb., 16-gage, 30 x 60 in., hard-rolled sheet is received. The question is: What size ingots shall this order be rolled from? The practical tendency in calculating would be to try a standard ingot, say 4 x 12 x 17, and see how this would work out as to scrap on shearing. The calculations for a 4 x 12 x 17 ingot would be:

0.125 ÷ 0.050 = 2.5, a factor.
The length of the sheet after scrap allowance may be taken as 75 in.
75 ÷ 2.5 = 30 in., the length of cut to be made on the cold slab after cold slabbing.
Referring to Tables XII and XIII, a cold slab run ¼ in. thick and 32 in. wide would be 160 in. long. 160 ÷ 30 = 5 times and 10 remainder.

Shearing as indicated would allow five pieces but 10 in. scrap.

This is rather high scrap loss, so it will be advisable to try another standard ingot. Such an ingot will be one measuring 4 x 12 x 20 in. The calculations for the size will be:

0.125 ÷ 0.050 = 2.5, a factor.
75 ÷ 2.5 = 30.
The length of a cold slab run ¼ in. thick and 32 in. wide from a 4 x 12 x 20 in. ingot will be 182 in. (a figure which can be obtained by calculations, and more readily in mill practice by drawing up a table similar to Table XII for ingots of this and other sizes).
182 ÷ 30 = 6 times and 2 remainder.

TABLE XIV. APPROXIMATE NUMBER OF SHEETS FOR VARIOUS GAGES TO BE ROLLED IN PACK

Gage*	Number of Sheets in a Pack	Gage*	Number of Sheets in a Pack
20	2	31	6
21	2	32	6
22	3	33	6
23	3	34	7
24	3	35	7
25	4	36	7
26	4	37	8
27	4	38	8
28	5	39	10
29	5	40	10
30	5		

* See Table XI.

Shearing as indicated would allow 6 pieces to be cut from each slab with only 2 in. of scrap. This is a better figure, and for the order in question, 4 x 12 x 20 in. ingots would be run.

The examples given above show in a general way what calculations arise in aluminum rolling-mill practice, and they indicate short methods for arriving at the desired results. At times, an order may be short of the required weight or number of sheets due to rejections by the inspector, because of wrong shearing, or because of scrapped slabs or sheets at the mills. No calculations can possibly remedy these difficulties. Accordingly, it is advisable to carry a fair sized stock of the sizes most often called for. Moreover, the requirements of the market, while varied, bulk very largely in certain sizes and gages, so that a stock may profitably be carried in order to fill short orders.

(Part IV, dealing with slabbing, will be published in our next issue.)

Picric Acid Plant Sold

The director of sales of the War Department announces that the Ordnance Salvage Board has sold to H. C. Couch, president of the Arkansas Light & Power Co., representing a group of business men of Little Rock, Ark., the acid-manufacturing plant near Little Rock, which was constructed by the Ordnance Department during the war for the production of picric acid. The price obtained by the Government for the property was $770,000. The purchasers were the highest of five bidders who submitted proposals for the property.

Magnesite Tariff Bill

At the hearings before the House Ways and Means Committee on July 16 and 17, 1919, of the magnesite tariff bill (H. R. 5,218), the producers of refractory magnesite were well represented, and the question of the use of magnesite in oxychloride cement received but scant attention. Calcined or caustic magnesite was included in the same classification as dead-burned and grain magnesite and the bill, as passed by the House, calls for a duty of ¾c. per lb.

However, at the hearings before the Senate Committee on Finance on Jan. 13 the composition floor manufacturers had an opportunity to present their objection to the tariff.

Calcined magnesite enters into the manufacture of Sorel cement, sanitary flooring, stucco, interior plasters and pipe insulation; a considerable business in these and other materials containing caustic burned magnesite has been built up in the past twenty years, it being estimated that in excess of 50,000 tons of crude ore was used in 1919, which is about 17 per cent of the total estimated domestic production. The producers represented that their products were in competition with other flooring materials, such as wood and ordinary cement, and that the additional cost which would be imposed should the tariff be granted would prohibit the use of their product. The present price of around $60 a ton for the caustic magnesite and $45 per ton for the chloride was compared with $25 and $16 respectively for the pre-war price and considered as sufficient to develop domestic production.

In addition the quality of the domestic caustic burned magnesite was represented as not being as uniform as that produced from Grecian ores, the principal source of foreign supply, and that because of the unreliable qualities an additional hardship was imposed upon the industry. The suggestion was made that magnesite containing an insufficient amount of iron to produce a satisfactory refractory be excluded from the provisions of the bill.

The use of magnesite in flooring for steel cars and boats, where its plasticity is an important quality, and in offices, hospitals and schools, where the sanitary and quiet features are of value, has been making particular progress during the past few years. A further important use is for exterior stucco, for which there is no practical substitute. This brings out the fact that magnesite is of wide usefulness outside the production of refractories.

German Nitrate Industry

The American Chamber of Commerce in Berlin has recently reported the results of its investigation into the present status of the industry. It appears that the entire production of nitrates in Germany is under the control of the Stickstoff Syndikat, with headquarters at Berlin. Both the Haber and cyanamide methods are used for fixation of nitrogen. The Haber plants are extensive and are located at Merseburg and Ludwigshafen. War-time developments have made Germany entirely independent of Chile, and not only will she supply her own requirements, but proposes to export fixed nitrogen as soon as her own needs are fully covered. Inland prices of nitrate and the various byproducts have been adjusted and are published in the *Reichs-Gesetzblatt*, 1919, No. 218. All questions of export and import are determined by the Stickstoff Syndikat.

Pulverized Lignite Fuel in California

By Roy N. Buell

EARLY in 1918, the hand of the Federal Government had been placed on the utilization of all fuel throughout the entire country, and in California, as elsewhere, the Fuel Administrator, in order to carry the state over a period of excessive need, had organized a corps of fuel engineers and inspectors to see that every possible source of supply was surveyed and that every pound of oil, coal or wood consumed was burned with a maximum of efficiency. The consumption of fuel oil was exceeding production by over 5,000 bbl. per day, and notwithstanding the fact that many non-essential plants had been entirely cut off, the shortage threatened to become more and more acute as time went on, unless some new source of fuel supply could be discovered.

SURVEY OF THE LIGNITE FIELD

It was decided to make a general state survey of all fuels with a view of finding some practical auxiliary for oil, and among the many possibilities to receive serious attention was California lignite. Large deposits of this material were known to exist in the Priest Valley, in which the Stone Canyon mine is situated; at Corral Hollow, where the Tesla mine is located; near Mount Diablo, at the old Black Diamond mine; in Dos Rios county, which was merely a good prospect, and in Amador county at the Ione coal mine. Experts from the United States Bureau of Mines and the technical staff of the State Fuel Administration were sent to examine these properties and report the possibility of using their output as an immediate source of domestic and commercial fuel.

The report submitted by these engineers was very thorough and complete, but hardly as reassuring in respect to the available fuel supply as had been anticipated. The Stone Canyon mine, while it contained by far the best coal in the state, could not be put in a workable condition for several months, and then at great expense. The Tesla mine, which had been worked many years before to a depth of about 900 ft. at three different levels, was found to be filled with water to within 300 ft. of the top, and aside from this a large amount of money

FIG. 1. INTERIOR OF IONE LIGNITE MINE, IONE, CAL.

would be required to replace tracks, elevators, tipples, etc., that had previously been either removed or destroyed. Other small deposits around Livermore, in the Mount Diablo district, were either undeveloped or completely worked out.

In Dos Rios county several test holes were drilled and much preliminary work was accomplished, but no large veins were discovered that would warrant further continuation of the work on a large scale. It was proved, however, that this particular deposit in Dos Rios county was a high grade variety of semi-bituminous coal, equal in B.t.u. content to the Stone Canyon product. Private parties have continued to explore this field and some well-known geologists have ventured their opinion that a large coal deposit will eventually be located.

IONE MINE CHOSEN

One of the last mines to be explored was that at Ione, and here the engineers found that coal was actually being mined and that the plant was prepared to turn out about 500 tons per day. In the old days, before the advent of fuel oil and the discovery of better coal in Wyoming and Utah, a large portion of the fuel consumed by the locomotives of the Southern Pacific R.R. was obtained from this mine. Many an old locomotive fireman can still be found in California who can tell you many interesting incidents concerning his experience with Ione coal.

After much discussion and careful consideration of the final report submitted by the engineers, the Fuel Administration decided that the lignite from the Ione mine, although of inferior quality, offered the best possibilities for immediate service. The next step was to determine the best method to be pursued in burning the lignite. The consensus of opinion seemed to be that the best efficiency in combustion could be obtained by drying, crushing and afterward burning the lignite in a pulverized state, properly mixed with air.

ADVANTAGES OF BURNING PULVERIZED LIGNITE

Among the advantages of burning the lignite in pulverized form, the one that stood out above all others was the fact that no matter how much ash the fuel contained it could be burned with good efficiency. Coal and lignites, having a large ash content, are difficult to burn on grates, owing to the fact that as soon as combustion commences the ash collects all around the carbon and completely shuts off the air. Besides this, the high volatile content of the lignite does not thoroughly mix with the air, so that the combustion of the gases is not complete without admitting a large amount of excess air, and even then the efficiency is poor. When the lignite is pulverized, however, the particles are so fine that approximately the proper amount of air to insure complete combustion surrounds each little atom of fuel, which condition not only guarantees high efficiency in burning but permits of easy and accurate control.

INSTALLATION OF EXPERIMENTAL EQUIPMENT

To carry on the necessary experimental work, preliminary to installing the process in large commercial power plants, it was decided to construct a small demonstration plant in San Francisco. Accordingly, a 50-hp. "Kewanee" return tubular boiler was equipped with the Buell-Santmyer pulverized coal system, which was considered best to burn the California lignite. Ione lignite, containing an average moisture of 40 per cent, as

mined, was allowed to air dry for seven days in shallow tipples at the top of the mine shaft, when it was shipped to San Francisco, in open cars, for treatment.

As received at the plant, the analysis was as follows:

	Per cent As received	Dry Per cent
Moisture	22.44	00.00
Volatile	43.37	54.60
Fixed Carbon	20.41	26.32
Ash	14.78	19.08
	100.00	100.00
B.t.u. per lb.	9,322	12,016

The fuel, as unloaded from the cars, was first crushed to about one-half inch. It was then dried in a semi-direct, artificially fired drier until the moisture content was reduced to approximately 6 per cent. One of the most important operations in the preparation of pulverized lignite is the drying process. At the San Francisco plant about one-sixth of the weight of the raw material was carried off as vaporized moisture, and to accomplish this, 50 lb. of pulverized lignite was consumed as drier fuel to every ton of dried product. The average temperature maintained inside the drier was 250 deg. F.. and great care had to be taken that the heat did not rise above this point, which is apt to cause spontaneous combustion or perhaps explosions.

After the lignite had been dried as described, it was pulverized to about 175 mesh, separated by air and stored in a concrete bunker, ready for use. One of the big bugaboos always brought forward in every argument against the use of pulverized lignite is that it is impossible to keep this material in storage for more than a few days without danger from spontaneous combustion. The writer's experience, however, seems to refute this claim, as he has known of one particular instance in California where several tons of powdered lignite was stored in a *metal* hopper for six months with apparently no ill effects whatsoever.

OPERATION OF COMBUSTION EQUIPMENT

The general layout of the combustion equipment used at the San Francisco plant is shown in Fig. 2. The pulverized lignite drops by gravity from the bunker into the feeder, where a screw conveyor, driven by a variable speed electric motor, carries the fuel to the mixer cham-

ber. Between the feeder and mixing chamber is situated a cross, with the upper connection left open, through which induced air may be drawn, aiding materially in stabilizing the pressure. An air compressor of the rotary type furnishes the necessary energy to transport the powdered lignite from the mixer to the combustion chamber, and supplies about 40 per cent of the air required for proper combustion, the other 60 per cent being obtained by induction.

The average air pressure employed at this plant was 3 lb. at the compressor and about 12 oz. at the burner. The powdered lignite, after meeting the compressed air at the mixer, is carried along through a 3-in. pipe to the burner, the most sensitive piece of apparatus in the whole plant, although very simple in construction. The focusing sleeve, on the end of the burner, is so arranged that the flame zone can be lengthened or shortened as desired.

A secondary air line, taken off the main line near the compressor, extends completely through the burner, with orifices near the extreme end looking back toward the front of the boiler, which acts as a brake on the main body of forced air and lignite. In actual combustion, this secondary air brake causes the flame corona within the furnace to expand or contract as desired. A half-inch steam jet was used to deflect the cutting flame away from the under side of the boiler plates.

The burner was lighted instantaneously with a torch through an opening in the boiler front. These openings were also used to allow more secondary air to enter the combustion chamber if required. About 15 per cent excess air was generally employed in combustion, although when the boiler was under peak load, this amount might be slightly increased. No changes worthy of note were made in the settings of the boiler, the object being to demonstrate how readily this system could be adapted to any ordinary boiler at small expense. The grate bars were removed, and later on an inclined fill was placed in front of the bridge wall to reduce back pressure.

To remove and collect the ash a permanent soot blower was installed in the front end of the tubes and an ash trap constructed under the rear end of the boiler, near the cleanout door. A complete set of instruments was installed to record the temperatures of the feed water,
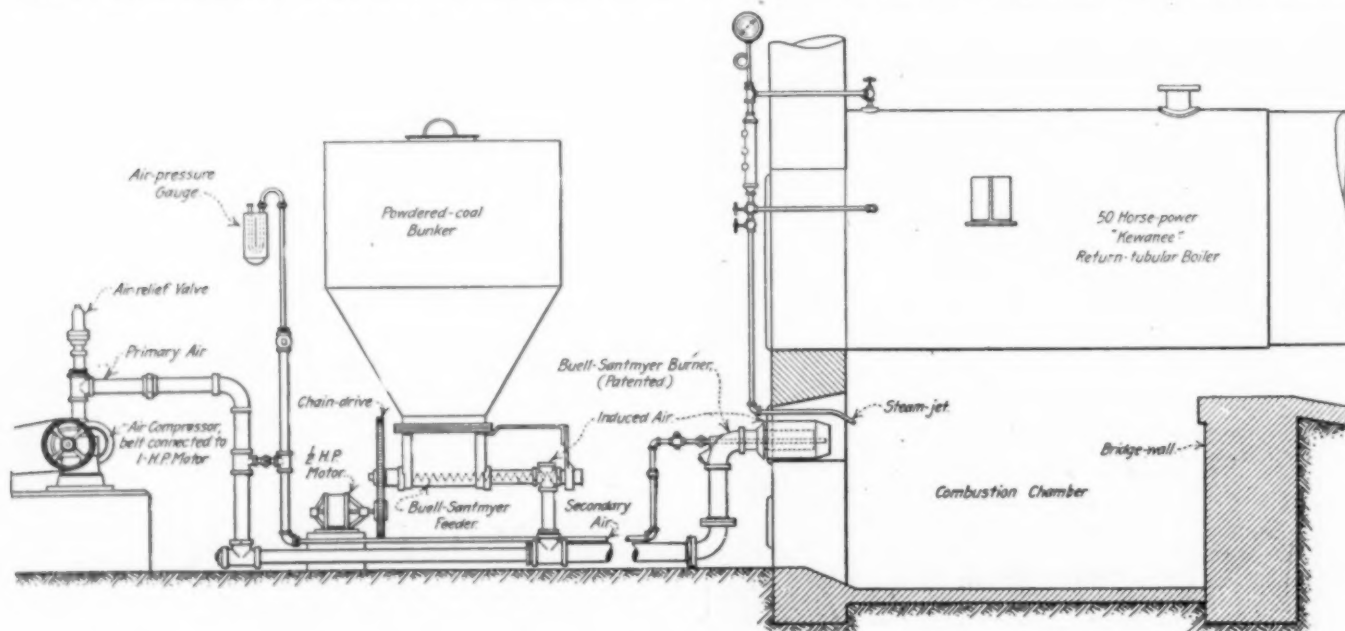

FIG. 2. GENERAL LAYOUT OF COMBUSTION EQUIPMENT, EXPERIMENTAL PLANT, SAN FRANCISCO, CAL.
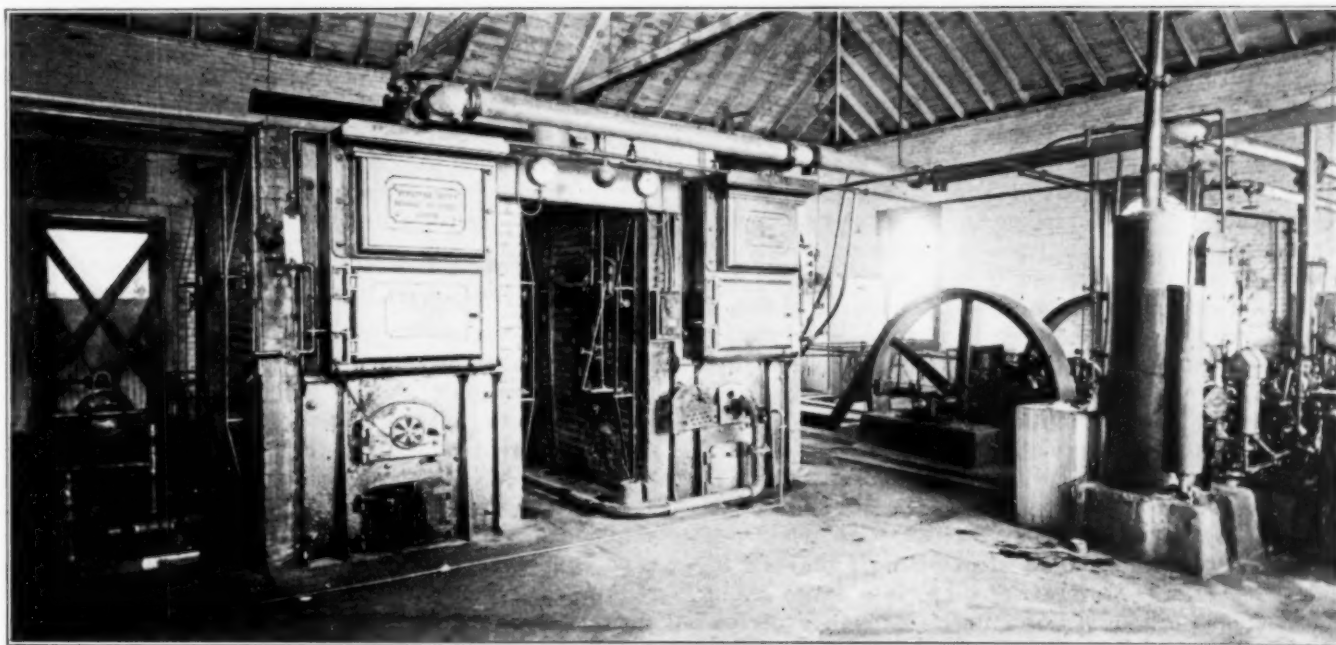
FIG. 3.   POWER PLANT AT STOCKTON, CAL., USING PULVERIZED LIGNITE FUEL.

the live steam, the combustion chamber and the waste gases, to determine the vacuum of the stack, draft, to weigh the feed water and to measure the steam flow.

RESULTS OBTAINED

Although the conditions for efficiency at the plant were far from ideal, some very good results were obtained, both as to combustion and boiler efficiency. The average evaporation per pound of dry fuel burned was 9 lb. of water from and at 212 deg. F.   The average temperature in the combustion chamber was around 2,300 deg. F. and that of the waste gases in the breeching above the boiler about 550 deg. F. The CO_2 content in the waste gases averaged 14.5 per cent.   The stack dampers were so adjusted that the vacuum in the rear of the combustion chamber was 0.02 in.   Fifty per cent of the ashes was carried out of the stack in suspension with the waste gases, 3 per cent lodged in the tubes and was removed by the soot blower and 47 per cent dropped either into the ash trap in the rear of the setting or onto the floor of the ash-pit in front.   The latter portion of the ash proved upon analysis to be largely silica and to contain about 0.005 per cent unconsumed carbon.

Many tests were carried out at this experimental plant for the benefit of California fuel engineers, and as a result of these successful demonstrations with lignite fuel plans were drawn early in 1919 for a large steam electric generating plant at the site of the old Tesla lignite mine and three industrial power plants at Stockton to use lignite from the Ione field.   A small plant has been completed at Stockton, where very gratifying results have been obtained, the powdered lignite being burned under Heine boilers, with equipment similar to that used at the initial plant at San Francisco.

When the plants now under construction in California are in actual operation and the efficiency experts have noted the great economy that will result in the generation of steam and for metallurgical purposes as well, the use of California pulverized lignite as an auxiliary to fuel oil and hydro-electric power will have received a great impetus and will without doubt soon take its proper place as a recognized and valuable California industry.

Industrial Representation in the Standard Oil Co.*

By CLARENCE J. HICKS†

THE labor policy of the Standard Oil Co. (New Jersey) is founded first of all on paying at least the prevailing scale of wages in the community; on the 8-hr. day, with time and one-half for overtime; one day's rest in seven; sanitary and up-to-date working conditions; just treatment assured each employee; payment of accident benefits beyond the amount prescribed by the state compensation law; health supervision by a competent medical staff; payment of sickness benefits after one year's service; co-operation with employee in promoting thrift and better social and housing conditions; and assurance for a generous annuity at the age of sixty-five, guaranteed for life after twenty years of service.   Most of these features have been a part of the company's policy for many years, but it is only during the past two years that the co-operation of employees in determining these matters has been definitely assured through industrial representation.

PRINCIPLE OF INDUSTRIAL REPRESENTATION

Industrial representation, in the Standard Oil Co., is a principle rather than a procedure.   It is built upon the belief that personal association of those interested in any problem leads to a mutual understanding and a fair decision as to what is right.   Fully believing in this principle, representatives of employees and representatives of management evolved a simple plan, the basis of which is that it gives every individual employee representation at joint conferences on problems and fundamental principles affecting all those interested in the industry.   It is based on co-operation, not antagonism; its operation makes perfectly clear both

to management and to employees that their interests are identical, that mutual understanding and co-operation insure progress and success for all. Furthermore, experience has definitely shown that representatives of the employees are not only alert for the employees' interests but are as keen as the representatives of the management in determining and insisting upon fairness to the employer.

Though the plan has been in operation nearly two years, it is an experiment, in that, being based on a principle rather than on cut-and-dried formulas of procedure, it is still subject to change and improvement. It has proved to be equally applicable in a refinery, where thousands of men are assembled, and in the sales department and producing field, where men are scattered in small groups over a wide territory. It is also in operation in several subsidiary companies. This adjustment to diverse conditions is possible because hard-and-fast rules were avoided in the belief that the human element must play an important part. Therefore the plan, to a large extent, has been permitted to build itself through experience and trial.

Co-operative Plan of Employers and Employees

The plan was brought into operation by an invitation to employees to co-operate in maintaining the company's established policy for fair treatment in matters pertaining to wages and working conditions. This invitation outlined a simple method by which the employees, by secret ballot, might elect from their own number men in whom they had confidence to represent them in conference with representatives of the management.

At the first joint conference a brief plan or agreement was evolved, which provided that adjustment of wages, including matters affecting working hours and working conditions, shall be made in joint conference between the employees' elected representatives in the division affected and the reprsentatives of the company. From the beginning, the plan stipulated that no discrimination shall be made by the company or its employees against any employee on account of membership or non-membership in any church, society, fraternity or union. Agreement was made as to offences for which employees may be dismissed without notice and also as to the offences for which an employee should be warned or suspended. Further, each employee was guaranteed recourse against unjust treatment or unfair conditions by means of a definitely prescribed method through which he, personally, or his representative may appeal his case to joint conferences of employees' and management's representatives and, if necessary, up to the highest officers of the company.

Joint Division and Joint Works Conferences

The joint works (or plant) conferences are held at regular intervals to consider all questions relating to wages, hours of employment, working conditions, and any other matters of mutual interest that have not been satisfactorily settled in the joint division conferences. These joint division conferences meet whenever needed to discuss and adjust matters within the smaller confines of a division. Many problems never go beyond the joint division conference, unless the problem develops into one that concerns other divi-

sions. In case any matters were to come up on which the joint works conference could not agree, they would be referred to the board of directors for final decision. But as yet not one case has been referred in this manner. The decisions of the joint works conference, when they involve serious matters, such as a general increase in wages, are subject to the approval of the board of directors.

Basis of Representation for Employers and Employees

At the inception of the plan, a basis of representation was determined upon that would allow one employees' representative to be elected by approximately 150 employees, with provision for a minimum of two employees' representatives from each division. In extending the plan to other departments of the company, such as the producing field and a refinery where fewer employees are required, this basis was amended to meet conditions obtaining in that field. On this point two essentials must be kept in mind: First, that an elected representative must not have more constituents than he can easily keep in touch with; second, that the joint conferences must not be so large as to be unwieldy at times when important discussion and decisions must be had. Experience has shown that there are many advantages to be gained by personal contact of employees' representatives and management's representatives, and therefore full joint conferences are preferable to numerous smaller subcommittees.

Other Protective Methods for Employees Maintained Solely by the Employer's Funds

Entirely apart from the industrial representation plan, but equally established as a policy in the Standard Oil Co., is a method of protection for employees and their families. This is attained in several ways: Group life insurance covering, at the company's expense, every employee after one year's service, affords some financial resources to dependents in case of death of an employee—a provision that was greatly appreciated during the influenza epidemic of 1918-19. There is a fully equipped and competently manned medical department to look after the health of all employees; and there is provision for half pay during a period of sickness. An annuity plan provides for employees who retire after twenty years of service or who are incapacitated after even shorter service. These forms of financial security are considered by the company as being good business and therefore are maintained solely by the company's funds, not by either voluntary or involuntary assessments on the employees.

Training Employees to Assure Opportunity for Advancement

The company is committed to a policy of training for employees as a means of assuring, to each one who desires, an opportunity for fair advancement to greater responsibilities. The administration of training is co-ordinated with other personnel functions, such as selection of new employees, transfers and promotions. Thus each employee not only has the feeling of security in his position and his earnings but also knows that the company is ready to help fit him for advancement to any position within his capacity.

Contemporary Foreign Opinion on Sulphur and Phosphorus in Steels

During a Trip to English and French Metallurgical Centers, Opinions Were Canvassed as to How Moderate Increases in Sulphur and Phosphorus Would Influence Laboratory Tests and Service Performance of Such Steels

By HENRY S. RAWDON
Physicist, Bureau of Standards

IN connection with the joint investigation now under way in America on the limits of sulphur and phosphorus in steel, a trip was made to England and France to consult the opinion of metallurgists, and of users of steels. An examination of available specifications, especially for railway steels, was made, and inquiry as to results of metal made and put into use under rather lax war-time specifications.

FRENCH SPECIFICATIONS

Inasmuch as French specifications for steels and similar metals are based on the foundation principle of mechanical properties, it is extremely difficult to obtain data and opinions offhand strictly applicable to problems arising in the consideration of specifications in accordance with American metallurgical practice. In specifying steels the criteria for acceptance or rejection are the mechanical properties. Chemical composition is regarded only as an index of the probable mechanical properties rather than as a characteristic of the material itself, and for this reason composition does not appear in French metallurgical specifications.

Consequently it was impossible to collect any experimental data from French metallurgical practice bearing directly upon the question of suitable limits for sulphur and phosphorus in steel. The discussion of the question was avoided, the reason given being that mechanical tests if properly conducted and interpreted will tell everything which is needed to be known, e.g., the results of shock tests will give good indications as to the phosphorus content, while the effects of sulphur may be gaged by "hot" and "cold" bends.

An official commission under the leadership of Le Chatelier and Guillet is now studying and codifying specifications for all materials of construction, but their work doubtless will not introduce a rigid adherence to chemical analysis. It is believed, however, that when the work of testing the various types of steel which are to be made has been carried far enough to warrant some conclusion being drawn, the information contained in the French specifications will be of value in showing to what extent the composition of the steels may be varied with respect to its sulphur and phosphorus content and still meet them satisfactorily. They may also offer some suggestions as to suitable tests to be made upon certain special products.

FRENCH METALLURGICAL OPINION

The following was formulated as the general opinion concerning the Bureau's program in the sulphur-phosphorus investigation after consultation with prominent French metallurgists:

Tension tests will tell but little concerning the effect of sulphur and phosphorus in the small amounts allowed, particularly if all the specimens are to be cut longitudinally from the steel. Sulphur as manganese sulphide in particular has its greatest effect in reducing the *transverse* strength of steel. Dynamic tests should also be made; in particular, impact or shock tests. It is in this respect that phosphorus has its pronounced effect.

All agreed that a preliminary examination should be made to determine to what extent segregation had taken place; this examination was ranked as of prime importance and a steel, e.g., of 0.07 per cent sulphur, if unsegregated, was mentioned as being preferable to one of 0.04 per cent S if pronouncedly segregated.

Regarding rivets of high sulphur content, the opinion was held that if the material can be worked to the shape of rivets satisfactorily, no trouble will be experienced in the later processes of riveting nor could any reason be given why material as high as 0.07 per cent sulphur should not behave as satisfactorily in service as steel of 0.05 per cent sulphur.

FRENCH RAILWAY MATERIAL

Great emphasis was placed by railroad engineers upon the preliminary metallographic examination for the purpose of revealing unsoundness and segregation. Although the material which has been put into service on the railways of France during the past few years has in many cases been far below the former standards, still no reliable data are available regarding its behavior. The conditions of service have been so severe and unprecedented that every bit of metal has been worked to the limit and removed either because of failure or wearing out. It is therefore not possible to express any reliable opinion as to its suitability for the service it was intended to stand.

In general, the French were of the opinion that American specifications for sulphur and phosphorus are too stringent and if care was taken to have uniform distribution of these elements in the material, it would be found that a steel of 0.07 per cent sulphur as compared with 0.05 per cent sulphur would meet all the required specifications as to mechanical properties and be suitable for use.

IDEAS OF ENGLISH METALLURGISTS

In England, as in France, but little experimental data bearing on the subject of the influence of sulphur and phosphorus were available and it was necessary to depend upon the opinions of those consulted. A research of value and interest in this connection is one that is being undertaken by the aëronautic section of the British Engineering Standards Association. In order to determine the effects of sulphur and phosphorus up to the prescribed war-time specification limits on cold-drawn carbon-steel tubing such as is used in airplane

construction, a series of ingots of steel of special phosphorus and sulphur content are to be obtained and then worked down into the form of tube and sheet and the product thoroughly tested. It is planned to collect ingots made under war-time conditions, of three sulphur contents up as high as 0.07 per cent (viz., 0.03, 0.05 and 0.07 per cent), with a high and low phosphorus content in each case. Later it is hoped that other types of steel entering into airplane construction will be investigated in a similar way. The fact that this research is being carried out along exactly the same lines as the one planned in the United States is evidence of the lack of available experimental data in English metallurgical practice from which a solution of the problem might be made.

On account of the larger number of metallurgists consulted in England a greater difference of opinion concerning the effects of sulphur and phosphorus upon steel was expressed than was the case with the French metallurgists. The following opinions concerning the program of the research outlined by the Bureau of Standards and its associates were expressed by nearly all consulted:

OPINIONS CONCERNING THE RESEARCH PROGRAM

The tests to be made should be of two general types, first, upon the behavior of the material during fabrication and second, mechanical tests upon the fabricated material. Tension tests should not be depended upon to differentiate the effects of sulphur in varying amounts no higher than those laid down in the program. The transverse tension test will be found much more useful. The opinion was held by some, however, that the difference between longitudinal and transverse tensile strength which exists in steel of normal sulphur content is often of sufficient magnitude to mask entirely any additional effect due to a higher content of sulphur. The importance of dynamic tests, particularly some form of impact test, was emphasized as well as the simple bend test.

The opinion was expressed by nearly all that if it were possible to form rivets satisfactorily from steel of rather high sulphur content they would behave satisfactorily during the riveting. A test suggested by several as useful in this case was a cold-heading process to determine the effect of the sulphur.

The importance of the examination to determine how uniformly the sulphur and other metalloids are distributed throughout the steel was emphasized strongly by all and the statement made that it would probably be found that in order to be absolutely safe it will be necessary to penalize a considerable amount of good material on account of occasional bad specimens due to segregation.

In regard to the general subject of necessary tests, one very eminent metallurgist said that no matter how many laboratory tests were made and how carefully they were carried out there is no way of translating the results obtained into service. The suggestion was made that in each case a comprehensive series of service tests should be made and that until the results of such service tests were available it would be unwise to change specifications which were known to be safe. In other words the wide margin of safety obtained with rather rigid specifications is a much wiser policy than an uncertainty due to new specifications which had not been fully and thoroughly tried out in practice.

Regarding the method of adding sulphur in making up the heats of special composition, all consulted were of the opinion that the sulphur should be added during the melting (preferably as iron sulphide) rather than at the end of the process. Phosphorus may be easily obtained from high-phosphorus pig iron; the use of screw stock high in sulphur and phosphorus is admirable for addition purposes in those heats in which a considerable amount of both sulphur and phosphorus is desired. It is essential, however, that the effect of each element be investigated alone before the more complicated case of the two combined be taken up.

It was thought that this difference existed between "residual" and added impurities: Residual impurities are more uniformly distributed throughout the finished steel, while added sulphur, for instance, may exist in considerable amount as ferrous sulphide and hence is apt to be more detrimental in its effects upon the properties of hot metal.

None of the men consulted would agree to the contention that within certain limits sulphur and phosphorus are not decidedly detrimental in themselves but are only indicators of some other undesirable condition. All were of the opinion that both sulphur and phosphorus had a characteristic effect upon the mechanical properties of the steel in which they occur, although such effects may be augmented by other undesirable conditions which may accompany amounts somewhat above the usual percentage. Such undesirable conditions may possibly consist, for example, in incomplete deoxidation or in the nature and distribution of the slag, more of it being retained by the metal. In general, however, most of the men consulted stated that they could not readily visualize and describe these concomitant conditions and were inclined to consider the matter worthy of very little consideration.

One important point brought out by a keen student of the question was that the simultaneous effect of carbon and phosphorus should be taken into account in the case of high-phosphorus steels. The hardening effect of phosphorus is much augmented by that of carbon, both elements affect the material in the same direction. In a low-carbon steel a rather high-phosphorus content can be used with safety, while the same amount in a high-carbon steel such as spring steel would be viewed with suspicion and alarm.

Among special tests mentioned as probably necessary for some products was a determination of the effect of high sulphur (and phosphorus) upon the corrodibility of the metal. This was mentioned as being of grave importance in the case of boiler tubes and other materials subjected to similar conditions.

DIVERGENT VIEWS OF ENGLISH MANUFACTURERS

Opinions held by representatives of different steel manufacturers on the subject of the effect of sulphur and phosphorus differed radically. The extreme view taken by one Sheffield firm was that they were convinced as a result of their war experience that a sulphur content as high as 0.07 per cent was entirely safe provided the steel was "properly controlled in the melting and pouring." Thousands of airplane crank shafts were made by this company during the progress of the war with a sulphur content as high as 0.07 per cent. It was claimed that there was no evidence that any of these had ever failed in service because of the higher sulphur content, although it is undoubtedly true that such ma-

terial is as severely stressed in service as anything in the entire engineering field. The stand is taken that sulphide of manganese is no more detrimental in its effects upon steel than are other inclusions and should be regarded in the same light.

The other extreme was held by another company in the same region, that anything that breaks up the continuity of the metal is to be regarded as detrimental to the steel and that the effort should be to produce steel which is as pure as possible in this respect. Hence sulphur should be maintained as low as possible in amount. The representatives of this company were quite frank in saying that they expected very little from the research that the Bureau has under way.

Most of the manufacturers, however, take an intermediate stand. Provided there is but little segregation and the metal is uniform in composition (special ingot types were recommended by some as being a desirable feature of the research on sulphur and phosphorus for this reason), the sulphur and phosphorus can be safely raised to a percentage of 0.07. By some this figure was placed still higher, 0.08 to 0.09, "depending upon the manufacturer who made the steel."

The suggestion has been offered by a few that the manganese content should be taken into account, particularly in those steels of high sulphur content. Most of the steel men, however, thought that for the range of sulphur content under investigation this was a refinement that would be beyond the control of the furnace man in making up his charge.

SULPHUR AND PHOSPHORUS IN RAILWAY MATERIALS

Although a considerable difference of opinion exists among users of this type of steel, it may be stated that the general tendency of the railways is to get back to the pre-war specifications as quickly as possible. Although it was necessary to relax the specification limits considerably during war time, the step was taken by the railway officials only with the understanding that the responsibility for anything arising from the use of such untried material should be assumed by the government.

It is felt that since the war-time experience with the newer material has been made under such unusual conditions of service, together with the fact that complete records of such materials were not made, there is no warrant for the continued use of this type of material. They are interested in obtaining material which they have found by experience to be entirely safe and claim to be finding no difficulty in obtaining it. It may be noted that in some cases the material used is not as closely specified in respect to sulphur as the present British Engineering Standards specifications call for. Locomotive crank axles, for example, are allowed 0.04 per cent sulphur by the specifications of the Midland Ry., while 0.035 is the amount allowed by the B. E. S. specifications. In general, the stand taken by the users of railway materials in England appears to be that the upheaval which occurred has not shaken their faith in their old specifications.

SUMMARY AND CONCLUSIONS

1. But very little data strictly applicable to the present research on sulphur and phosphorus in steel were obtainable in either England or France. This is partly accounted for by the different basis used abroad in drawing up specifications for metals.

2. A research conducted along exactly the same lines is now being carried out by the British Engineering Standards Association to determine the effect of sulphur upon a certain type of steel product. The inference to be drawn is very evident—there are no data available for settling the question, but direct experimental evidence must be resorted to.

3. The much-used tension test is to be regarded as only a start in the mechanical testing necessary for determining the effects of varying amounts of sulphur and phosphorus upon steels. Dynamic tests should be given full consideration as well as tests which will show the properties of the metal in a transverse as well as in the longitudinal direction. The behavior of the material during fabrication should be regarded as one line of testing of equal importance with mechanical tests on the finished metal.

4. The necessity of extensive service tests was emphasized, since no matter how many laboratory tests are carried out there is no way of interpreting such tests in terms of ordinary service.

5. The opinions expressed by manufacturing metallurgists differ very widely as to permissible limits for sulphur, diametrically opposing views being taken.

6. Regarding the method for obtaining suitable sulphur and phosphorus contents in experimental heats to be made, the general opinion appeared to be that the additions should be made during the heat and not at its close. Regarding the subject of "residual" vs. "added" sulphur, the general opinion was held that the difference consisted largely in the physical condition of the two and no *clear, definite* expression of opinion could be obtained as to the possible detrimental effect of some obscure condition accompanying high percentages of sulphur and phosphorus.

7. The general tendency of the English railways is to revert to the pre-war specifications for ordering materials. No such generalization can be made regarding the French practice, on account of the greater effect that the war had upon the systems as well as the fact that at the present time all specifications are being reviewed and unified by a national commission appointed for this purpose.

Meeting of Electric Furnace Association

Definite plans have now been made for the meeting of the Electric Furnace Association in Boston. The business meeting and election of officers will be held at the Copley-Plaza Hotel at 1 p.m. on Thursday, April 8, and will be combined with a luncheon. At 2 p.m. there will be a general meeting, also at the Copley-Plaza, which will be open to all who are interested in the electric furnace industry. The subject of the discussion will be "Adequately Trained Men an Urgent Need of the Electric Furnace Industry." This subject has been chosen at the instance of a number of electric furnace operators. Papers have been prepared by makers of furnaces and equipment and by electric steel manufacturers. A number of engineering institutions will also discuss what they are doing to train men for metallurgical work.

On Friday, April 9, the Association will join with the American Institute of Electrical Engineers and the American Electrochemical Society in their discussions on "Electrically Produced Alloys" and "Power for Electrochemical Purposes." During the afternoon all three organizations will probably make a trip to the plant of the General Electric Co. at Lynn.

The Physical Condition of Workmen

By Chesla C. Sherlock

COMPENSATION is ordinarily payable to workmen who have been injured through accidents which arise in the course of the employment, as well as out of it. If the workman dies as a result of his injury, the compensation is payable to his dependents.

All workmen, unfortunately, are not of the same physical condition at the time of their injury. A slight strain that would not affect a normally healthy man in the slightest may cause the death of a workman suffering from heart trouble.

The question naturally comes to every employer, at some time or other, whether the law intends to hold him liable for the physical condition of his workmen in a compensation way. Is the employer entitled to charge off the pre-existing condition of the workman?

Here we have a workman who has served his employer through long years at heavy labor. In the course of time, he is unable to continue at work; he is like an old broken down horse; he has suffered a cardiac breakdown which absolutely prevents him "carrying on." Is he entitled to compensation?

Instances Cited

In another instance, a workman may be suffering from heart trouble. He has been warned by his physician not to do any lifting and to be very careful as to the sort of work he does. But in the struggle for a livelihood he takes a job at lifting and conceals from his employer the facts in his case. To the employer he is apparently able-bodied and capable of carrying on the work. A few days after he goes to work, the strain is too much for his weakened heart, and he dies. Is he entitled to compensation?

In another case, a workman may apparently be in fine health and spirits. He has been concealing a hernia from his fellows, fearing that if it were known he would be discharged. In the course of his work, he is called upon to do some lifting which would not in any way affect a normally healthy man, but in his case it strangulates his hernia and he dies before relief can be secured. Is he entitled to compensation?

Or, and this case is not so visionary as it might seem, suppose that a workman is unable to get up on "high places." He is required to wash windows or repair roofs and, finding himself on the high spot, suffers a faint spell, falls and injures himself, or because of his weakened heart has an attack of heart failure and dies. Is he entitled to compensation?

I might enumerate many other instances such as these, but that is unnecessary. What the employers want to know is the law and the basis upon which the courts and commissions arrive at their decisions.

The General Established Rule

The question of pre-existing condition is one of the hardest that ever confronted the courts under the compensation system. A general rule has finally been established which is, I think, generally accepted as being a happy solution of the problem.

The underlying principle of the compensation acts, it will be recalled, is that since the workman has, during his productive years, added something to the wealth of society, society should compensate him (share his loss) when industry robs him of his earning capacity.

This is a great, humane principle, and as near a socialistic principle as you will find supported anywhere by the law.

If the physical condition of a workman was to be taken into consideration, it would be possible for the employer to defeat the very purpose of this principle, in many cases, by using the workman up to the point where he develops, or is about to develop, incapacity or predisposition to injury or disease, then discharge him and prevent him obtaining compensation. It would further operate to close the doors of industry to this man so that he could not obtain employment elsewhere, for no employer would be willing to run the risk of employing the fellow, under the circumstances, and having him "die on his hands."

It would mean that employers would have to take physical examinations of their workmen at regular intervals, especially in first employing them, in order to protect their own interests. This would not only add a burden to the cost of labor turnover and management but it would operate to destroy the effectiveness of the compensation acts, except in clear-cut cases of injury by accident.

Attitude of the Courts

The courts were fortunate in early seeing the matter in this light. They said that it is unfortunate if an employer employs a man who is predisposed to injury or disease, because of impaired physical vigor, but the law cannot take any affirmative action in the matter. If the man employed is sufficiently able-bodied to be hired by the employer, then the employer cannot be heard to come into court when subsequent events disclose that the workman suffered from pre-disposition to injury or disease and whine about his tough luck. To permit this would be to destroy the very underlying principle upon which the compensation system rests.

And so we find the courts saying that compensation is not necessarily barred because a claimant suffered from an impaired physical condition which rendered him more susceptible to injury than a normally healthy man.

It must be remembered, however, that the right to compensation is based upon an injury by accident arising out of and in the course of the employment. If the workman is doing something which produces an accidental happening injuring or incapacitating him, however slight it may be, he is entitled to compensation regardless of his pre-existing physical condition.

But as an English court has said: "No compensation is recoverable for incapacity caused by cardiac breakdown which was not due to any sudden strain, but was the natural result of the workman continuing to do work which was too heavy for him."

The rule is stated in this country that if the workman was doing his ordinary work in the ordinary way and something happened causing him to die or become incapacitated, he cannot receive compensation, as the injury clearly arose out of his impaired physical condition, there being no fortuitous event at the time indicating that it arose by accident out of and in the course of the employment.

It is a general rule that if, at the time of the accidental injury, the workman was capable of performing the work of an able-bodied man *in that employment*, pre-existing conditions cannot be successfully pleaded in bar of compensation.

Legal Notes

By Wellington Gustin

Duties and Liabilities Where Wrong Products Are Delivered—Express and Implied Warranties

Some very workable points in law are involved in the case of Samuel and others against the Delaware River Steel Co., recently decided in the Supreme Court of Pennsylvania. (107 A., 700.)

It appears that the steel company purchased two carloads of "roll scale" from plaintiffs, who are brokers in steel and iron products at Philadelphia, to be delivered to defendant at Chester, Pa. Plaintiffs purchased the roll scale from the Lebanon Valley Iron & Steel Co. and ordered shipment made directly to defendant's mill. The defendant claimed that upon unloading the material it was found one of the cars contained largely "mill cinder," a product of less value than roll scale. However, the entire shipment was used within the day following delivery. A week later a formal written complaint was made by defendant saying that the material in one of the two cars consisted approximately of 75 per cent cinder and 25 per cent roll scale, and that it would expect the bill to be rendered on that basis. Later defendant proposed to pay the market price of cinder, and this offer was refused by plaintiffs, who contended that the product delivered was roll cinder, and further that even if it were not such product, by accepting and using the car before making complaint defendant waived the right to object that it was not the article ordered.

This became the issue in the case. The trial judge submitted to the jury the question whether the material delivered was roll scale or mill cinder, with the further instruction that if it found it was mill cinder, to determine whether it was practicable for the defendant to have offered to return the product, and that if mill cinder was delivered, if defendant discovered the fact before it was used, there should have been an offer to return, and in absence of such offer defendant would be liable for the contract price. On this the plaintiff was given a verdict by the jury for the difference between the amount paid by defendant and the price of roll scale. Now, this trial court held that it was the duty of the defendant to notify the plaintiff, upon discovery that the product received was not "roll scale," and before using same.

On appeal to the Superior Court the judgment was reversed, because it held that the proposition of law laid down above was error. However, in reversing this, the court directed the entry of judgment for defendant, and from this judgment an appeal was made to the Supreme Court.

Implied Warranty, Like the Express Warranty, Survives Acceptance

This last court said it was well established that, in the sale of a chattel by sample or description, an implied warranty attaches that the article shall be of the kind ordered.

Now, where there is an express warranty the general rule is that it survives acceptance of the goods, and the purchaser may thereafter sue for the breach of said warranty, or may set off damages for such breach in an action brought by plaintiff for the purchase price of the goods.

And now the question is whether the implied war-

ranty, that the material was of the kind ordered, was also one which survived the acceptance and use of the material without previous notice to the plaintiffs. Said the court, there was considerable conflict of opinion in the authorities, but the greater weight in courts of other states was that the implied warranty, like the express warranty, survives acceptance, even though the defects were known at the time the commodity was accepted and used. And so the court held. Notice to plaintiff before use was unnecessary.

However, it found that the Superior Court also fell into error in directing judgment for defendant in that plaintiff's evidence that the material furnished was roll scale, though contradicted by defendant's evidence that it was mill cinder, made a question for the jury to decide.

Hence it was ordered that a new trial be had to determine that question.

International Forge Co. Judgment Affirmed by Pennsylvania Supreme Court

In the case of the International Forge Co., Inc., against Paul S. Reeves & Co., Inc., to recover the value of certain lost metal, the judgment for plaintiff for $2,146.35 has been affirmed in the Supreme Court of Pennsylvania. (107 Atl., 837.)

The Reeves company had entered into a written contract with the plaintiff, the International Forge Co., to manufacture castings out of materials to be furnished by it. This contract provided that the Reeves company should "stand all metal losses," and this action was brought to recover the value of lost metals furnished to it.

There were originally two assignments of error given as reasons for asking a reversal of the judgment. The first was withdrawn and the second was not supported by proper complaint. Hence the judgment was affirmed.

Liability for Guaranteed Analyses

The constitutionality of the Florida laws regulating the sale of fertilizer was recently presented to the Supreme Court of Florida in the case of Adams against the American Agricultural Chemical Co. The plaintiff had entered suit against the defendant company, alleging that the defendant, being engaged in the business of handling and selling commercial fertilizers, sold to him fertilizers bearing a stated guaranteed analysis, and that upon an analysis made by the state chemist, it was discovered that plaintiff had been defrauded by reason of deficiencies of constituent elements in the fertilizer, and the plaintiff claimed double the price of the fertilizer as his damages, as provided by statute. Among other grounds, the chemical company defended on the contention that the sections of the statutes as named above were unconstitutional, for the reason that their effect is to deprive fertilizer manufacturers and dealers of their property without due process of law.

Provisions of the Statute

The first section of the statute referred to provides for an analysis of the fertilizer purchased, by the Commissioner of Agriculture, and the second permits a recovery of twice the amount paid for the fertilizer. The last-named section contains this provision: "In case any purchase be made of any manufacturer or agent of any person or persons residing out of the State of Florida, manufacturing, compounding or furnishing

for sale any such commercial manure or manufactured fertilizer, cottonseed meal, castor pomace, tobacco stems, tobacco dust or tobacco meal, the purchaser thereof may, at his option, proceed by attachment, as now provided by law in case of non-resident and absconding debtors, against any such property, rights or credits of any person or persons selling, manufacturing, compounding or furnishing said manures or fertilizers when such property, rights or credits can be found within the limits of the state."

DICTUM OF THE COURT

Passing upon the question involved, the Supreme Court said in effect (82 So., 850): "Section 1,272, General Statutes of Florida, gives 'to any person purchasing any fertilizer or fertilizing materials from any manufacturer or vendor who shall . . . discover that he had been defrauded by reason of adulteration or deficiencies of constituent elements, . . . in the fertilizing material so purchased,' a right of action against the manufacturer or vendor, and the right thereby given is not limited to those who discover such fraud 'upon an analysis by the state chemist.'

"Section 1,271 . . . provides a method by which the user of fertilizer, if he be a citizen of this state, may determine whether his fertilizer measures up to the guaranteed analysis, and allows him to use the certificate of the state chemist as prima facie evidence in any suit brought under section 1,272; but such certificate, while competent, is by no means exclusive evidence as to the real analysis, the state chemist being subject to the ordinary rules of cross-examination and contradiction.

"The cause of action given by section 1,272 lies in fraud, and the declaration should be based upon the fact of the fraud, and not upon the analysis by the state chemist; such analysis being evidence only of the real cause of action, to wit, fraud.

"The primary purpose of section 1,272 is to afford compensation to the purchaser and user of fertilizer for his probable, though uncertain, loss resulting from the use of inferior fertilizer. The measure of recovery is in the nature of liquidated damages.

"Sections 1,271 and 1,272, General Statutes of Florida, do not appear, from the facts presented, to deprive the defendant of property without due process of law, nor to deny to it (a corporation) the equal protection of the law, contrary to the state or Federal Constitution.

"The requirements of due process of law and of equal protection of the laws are satisfied if there is no unauthorized and merely arbitrary exercise of the powers of government, to the detriment of the people, or some of them; and inasmuch as the statutory damages of double the price paid for the fertilizer are not shown to be unjust, unreasonable, nor arbitrary in this case, and inasmuch as the statute applies alike to 'any manufacturer or vendor' of fertilizer, the constitutional rights of the defendant do not appear to have been violated.

"A corporation is not a 'citizen,' within the 'privileges and immunities' provisions of the Federal Constitution.

"One who is not himself denied some constitutional right or privilege cannot be heard to raise constitutional questions on behalf of some other person, who may at some future time be affected."

Therefore the judgment of the trial court in favor of the chemical company, which had contended the statutes were unconstitutional and void, was reversed.

Air Conditioning Prevents Explosions Ignited by Static Electricity

ONE of the three principal dangers of factories where quantities of chemicals are being handled is that of explosion due to chance sparks from static discharges, and this is one of the most subtle (because frequently untraceable) causes of such accidents. Oftentimes such explosions result disastrously, and case after case remains, in its origin, a mystery, the safety engineers of the factory not being able to determine beyond doubt the direct cause, because of some hidden and unusual static cause, a "freak"— and freaks are something to which static discharges are very liable.

Of serious consequence is the low relative humidity in the winter, when the possibility of static discharge is greatly increased.

The safest way to prevent such explosions, due to the ignition of mixtures of combustible vapors and air, is in the use of all reasonable precautions, and then an air-conditioning system which eliminates dangerous atmospheric conditions. Properly-conditioned air is "climate made to order." It means air that is sufficiently moist to cause the air to become a good conductor and carry away the charge as formed, and prevent it building up a sufficient potential to form a spark. Dust particles, being moistened in this way, tend to fall to the floor, rather than float in air currents. But the air must be sufficiently dry so that chemical work may be carried on entirely free of all risk that hydroscopic materials will absorb moisture.

According to the B. F. Sturtevant Co., of Boston, specialist in air conditioning, the field of chemistry and metallurgy has furnished one of the most severe tests of the application of air conditioning which could be imagined. That it has emerged from this test with ample proof of its value and advantages not possible in any other way has been established in all cases and under a great variety of conditions. To quote the Sturtevant company:

"The exact nature of the work done in the chemical laboratory, manufactory, dye house and mixing room calls for minute care in temperature and humidity, if ideal results are to be realized. This is more or less of a truism, but even now all concerns do not fully recognize the important part that atmospheric conditions play in the rate of production.

"When important work is in process, calling for the combination of chemicals under certain definite conditions, a degree one way or the other may mean all the difference between success and failure. Or it may possibly be the means of a disastrous explosion, as was the case some time ago with a large plant which was completely destroyed, due to a chance frictional spark caused, possibly, by a too-high static condition in the atmosphere. With proper air conditioning, chemical processes and combinations involving the handling sometimes of highly hydroscopic materials are performed under ideal conditions, assuring maximum success in results. Where moderate temperature is required, where humidity must be accurately regulated and maintained, where weather conditions cannot be allowed to interfere with difficult and costly work, there air conditioning has proved its vital usefulness in plants of every kind, all over the country."

Synopsis of Recent Chemical and Metallurgical Literature

Colloidal Clay Soap.—What is described as a revolution in soap making is the subject of a lengthy and analytical article in *Chemical Age* (London) of Jan. 17, 1920, in which the use of colloidal clay as an addition to or as an alternative for some of the customary constituents of soap is shown to possess properties of great value.

F. E. WESTON, the writer of the article, is stated to have been associated in a consultative capacity with an important industrial undertaking in connection with the utilization of colloidal clay. This clay, he states, "belongs to the general class of 'suspenoids' and is a reversible colloid, since it is possible to disperse it in water or throw it out of colloidal solution at will.

"True colloidal clay is prepared from china clay. One of the many and varied applications of colloidal clay is that of its use as an adjunct in the manufacture of soap, not as a 'filling' material or as an adulterant, but as an actual substitute for soap material."

After describing the usual constituents of soap, Mr. Weston refers to the conclusion arrived at by Spring that the concentration of soap on the surfaces of the adsorbing bodies is the chief factor in the detergent action of soap. According to Michaelis, adsorption is the greatest for those substances which produce the greatest lowering of the surface tension of a liquid when in solution in that liquid. He points out that soap dissolved in water considerably lowers the surface. tension of water against air; that clay can be brought to such a highly colloidal state that it closely resembles soap in its physical behavior; and that when properly incorporated with soap it actually increases the lathering and detergent properties of the latter. "Chemically, soap and clay belong to two distinct types of compounds. Physically, however, the solutions of these bodies resemble each other closely; they both possess emulsifying power, both have the power of 'adsorbing' dirt, grease, etc., and both have detergent properties."

Incorporated with soap, the clay tends to lower the surface tension of water to a greater extent than soap itself. Experiments with high-class toilet soap and a soap made up of 80 per cent soap plus 20 per cent colloidal clay showed that the soap containing the colloidal clay lowered the surface tension 9.1 per cent and 6.9 per cent more than the pure soap, at 20 and 45 deg. C., respectively. Lathering experiments were also carried out, and the lather obtained by adding collodial clay to the soap was found to be much greater than that obtained by the soap itself; moreover, in all cases the lather was of a firmer nature and was more persistent.

Other experiments are described by Mr. Weston, and objections against the use of alkalis to increase lathering and detergent properties of soap are given, and he proceeds to state that the custom of taking, as a criterion of a soap, the percentage of fatty acids present therein will no longer hold good, "since colloidal clay contains no fatty acids," whereas the experiments show that such clay increases the lathering and detergent properties of soap. It is not asserted at present, however, that fatty acids can be entirely dispensed with, but that their present proportion can be halved. It is pointed out that colloidal chemistry "in its application to industrial problems is only just beginning to be realized"; it is a "branch of chemistry still in its infancy."

In conclusion, it should be noted that *Chemical Age* remarks: "According to Mr. Weston, the colloidal clay, which forms the subject matter of his article, is prepared by a patented colloidal process, and it would appear that many varieties of clay, both in Great Britain and in other countries, may be found amenable to the process."

Old Rails With High Internal Strains Contained No Fissures.—Significant studies of old rails were carried out recently to test the theory that transverse fissures in rails are produced by permanent strains set up by the distortion of the metal in service under rolling loads. As detailed by W. C. CUSHING, chief engineer of maintenance, Pennsylvania Lines West of Pittsburgh, in a report (No. 84) to the rail committee of the American Railway Engineering Association, a number of old rails were taken out of the track and examined for structure, internal strains, segregation, and existence of transverse fissures.

Rails that had been in service from ten to forty-five years were examined; some of the oldest were of wrought iron, others rolled from iron and steel pile, while those ten to twenty-five years old were of bessemer steel. All of them "were carefully examined for transverse fissure defects, but none were found." Nevertheless their internal strains were very high according to 10-in. strain-gage measurements which were made on various strips $\frac{1}{2}$ x $\frac{1}{4}$ in. cut from different parts of the rails.

In the old wrought-iron rails, head strains corresponding to 24,000 to 27,000 lb. per sq.in. in compression were found, which appeared the more serious because the material had a low elastic limit, 26,670 to 48,760 lb. per sq.in. The piled rails showed maximum head strains of 24,000 lb. per sq.in., and the elastic limit of the material ranged from 33,700 to 53,830 lb. per sq.in. Still higher internal strains, however, were found in steel rails that had been in service twenty to twenty-five years, several measurements of 36,000 and 33,000 lb. per sq.in. being made, as against elastic limits of 46,500 to 58,450 lb. per sq.in. These high values of permanent strain were measured at the surface of the head and on the side opposite the gage side, in nearly every case. One abnormal result was a reading of 57,000 lb. per sq.in., tensile stress, in the flange of an 85-lb. rail that had been in service from 1898 to 1917; Mr. Cushing calls this "extraordinary and inexplicable."

Segregation was rather high, particularly in the rails exhibiting the highest internal strains, and at the same time these rails showed low elastic-limit load in the quick-bend test (though not in tests in direct tension). Mr. Cushing concludes:

"If severity of service, especially by exceedingly heavy wheel loads, be the sole cause of the defect known as transverse fissure, these rails, after their unusually long service, and in some of the cases under the heaviest wheel loads in use, would be sure to be filled with transverse fissures. That such was proved by careful examination not to be the fact, that rails adjacent to and undergoing precisely the same conditions of serv-

ice as those in which transverse fissures have been found do not have any, and that rails never put into service as well as those which have been in service have been shown by Waring and Wickhorst to contain microscopical cracks, seems to prove beyond a doubt that the cause, the real cause, of transverse fissures must be sought in the process of manufacture. The wheel loads are the instruments of development from the initial defect, and it is true that the service has become uncommonly severe."

Transformers for Electric Furnaces.—J. L. THOMSON gives in the London *Electrician* of Jan. 30 and Feb. 6 a comprehensive discussion of the present and future status of transformers for electric furnace work. The author states that at the present time electric steel furnaces have been designed for capacities of fifteen tons and that the future will demand larger sizes up to thirty or forty tons. Assuming that 200 kva. is required per ton, transformer groups of 6,000 to 8,000 kva. will be required. While transformers of larger capacities have been designed, this particular problem is complicated by the low voltage and heavy currents required. The writer then deals with the design of the furnace with special regard to the heavy magnetic fields involved, the
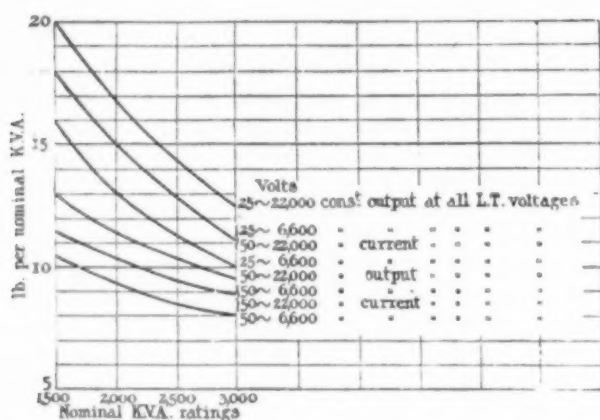
APPROXIMATE WEIGHT OF FURNACE TRANSFORMERS

mechanical stresses and furnace layout. He states that in order to reduce the possibility of a heavy choking effect and unbalanced voltages, the following suggestions may be useful: (1) Transformers should be placed as near to the furnace as possible, so that heavy low-voltage leads may be of minimum length. (2) Low-voltage leads of the various phases should be symmetrically placed with respect to transformers and furnace. (3) The area between positive and negative low-voltage leads should be as small as possible and also that between phases so that inductance may be a minimum. (4) Low-voltage leads for heavy currents (above 5,000 amp.) should be in multiple and interleaved from the transformer to a point as near the furnace as possible. This will keep the inductance low and make that of each lead approximately the same, thus insuring that each parallel lead takes its proper share of the load. (5) Heavy current leads should not be run near any heavy magnetic structure such as girders or supporting columns unless both the positive and the negative leads are run together and interleaved. (6) No magnetic material should form a closed circuit around any positive or negative conductor, or heavy currents will be induced in that circuit. The positive and negative conductors interleaved may be run through a magnetic circuit. Clamps for heavy-current leads should be of non-magnetic material.

Recent Chemical and Metallurgical Patents

Camphor From Isoborneol.—Nitric acid, 600 lb., sp.gr. 1.4, is placed in a stoneware kettle provided with a stirrer, and heated to 40 deg. C. Two platinum electrodes in the form of plates (1 in. wide x 6 in. long) separated by insulating blocks are suspended in the acid. While the stirrer is at rest about 0.5 lb. of isoborneol is dropped upon the top of the immersed electrodes and a current of 1.6 volts and 30 amp. passed until the reaction has started, as shown by the evolution of red fumes. The electrodes are now removed and isoborneol added in small quantities with constant stirring until 150 lb. has been added. The temperature is held at 40 deg. C. by means of cooling coils. The camphor nitrate which floats as an oil on the surface of the weak acid is decanted and drowned in an excess of water, whereupon it breaks up to form camphor, which is washed, dried and purified by sublimation. (1,324,140; ROLAND L. ANDREAU, of Wilmington, Del., assignor to E. I. du Pont de Nemours & Co.; Dec. 9, 1919.)

Toluene From Xylene or Solvent Naphtha.—BENJAMIN T. BROOKS, of Pittsburgh, Pa., has found that the xylenes, which are of little commercial value, can be converted into toluene by a "cracking" process. Crude solvent naphtha containing 70 to 80 per cent of the three xylenes is heated with dry aluminum chloride under a reflux condenser so regulated that the toluene vapors can escape as formed, at a temperature between 105 and 115 deg. C., while the xylene vapors are returned to the still. The condensate will generally run about two-thirds toluene, one-sixth benzene and one-sixth heavy oils (xylene, etc.), and may be fractionated in a suitable still. (1,324,143; assigned, by mesne assignments, to E. I. du Pont de Nemours & Co.; Dec. 9, 1919.)

Strontium Peroxide.—When strontium oxide is heated to about 400 to 500 deg. C. with oxygen at a pressure of 1,500 to 1,800 lb. per sq.in. strontium peroxide of high test (over 85 per cent SrO_2) is formed. (1,325,043; JAMES B. PIERCE, JR., of Charleston, W. Va.; Dec. 16, 1919.)

Pyrocatechin Aldehyde.—If piperonal is treated with thonylchloride at the temperature of the water bath, a reaction takes place according to the equation:

$$R.CHO + SOCl_2 = R.CHCl_2 + SO_2 \quad (1)$$
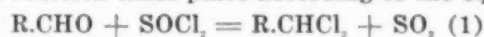
By treating the piperonaldichloride (piperonylchloride) thus obtained with four molecules of chlorine, dichlorpiperonylchloride is formed. This compound when hydrolyzed yields pyrocatechin aldehyde, carbonic and hydrochloric acids being split off. Reaction (1) is excellently suited for the protection of the aldehyde group, so that a good yield of pyrocatechin aldehyde is obtained. (1,326,793; LUDWIG SCHMIDT, of Munich, Germany; Jan. 6, 1920.)

Hexanitrodiphenylamine.—It has previously been considered impossible to use mixed acid in the preparation of symmetrical 2.4.6.2'.4'.6'-hexanitrodiphenylamine from 2.4-dinitrodiphenylamine. The usual procedure has been to nitrate the latter compound

with 50 per cent nitric acid to form 2.4.2'.4'-tetranitrodiphenylamine, and to complete the nitration with 90 per cent acid. In working with such concentrations of nitric acid, the use of lead lined or enameled vessels is imperative. JOHN MARSHALL, of Swarthmore, Pa., has devised the following procedure, in which mixed nitric and sulphuric acids are used as the nitrating agent: Into an iron water-jacketed vessel provided with a stirrer is introduced one part by weight of 2.4-dinitrodiphenylamine at a temperature of about 70 deg. C., together with five parts by weight of mixed acid containing approximately 30 per cent nitric acid, 55 per cent sulphuric acid, and 15 per cent water. Thereafter the temperature is raised to from 80 to 90 deg. C., in any suitable manner, and the agitation is continued at this temperature for approximately one hour. Thereupon the mixture is cooled to 30 deg. C., and the solid 2.4.2'.4'-tetranitrodiphenylamine is separated from the spent acid by filtration. The material thus obtained, in an acid condition, is added, at 70 deg. C., to five parts by weight of mixed acids containing 20 per cent nitric acid, 75 to 80 per cent sulphuric acid and 5 to 0 per cent water in the vessel previously referred to. The mixture is then raised to 80 to 90 deg. C., and kept at this temperature for from 1 to 2 hr. The solid 2.4.6.2'.4'.6'-hexanitrodiphenylamine is separated from the spent acid by filtration, is drowned in water, and washed with hot water until freed from acid. Afterward it is centrifuged from the wash water and dried. (1,326,947; assigned to E. I. du Pont de Nemours & Co.; Jan. 6, 1920.)

Recovery of Molybdenum From Its Ores.—HENRY ALFRED DOERNER of Meriden, Conn., has developed a process whereby molybdenum may be recovered from its ores by heating to about 500 deg. C. in a stream of chlorine gas. The molybdenum is volatilized as chlorides or oxychlorides, and these may be condensed, or may be decomposed by steam or water into oxides and hydrochloric acid. By maintaining the condenser at a temperature of 200 deg. C., the hydrochloric acid may be separated from the oxides and recovered in a separate condenser. (1,329,380; Feb. 3, 1920.)

Purification of Zinc Solution.—The successful deposition of zinc by electrolysis from the sulphate solution obtained by leaching roasted zinc-bearing material with solutions containing sulphuric acid is dependent upon the production of a solution of a high order of purity and entails the elimination of such impurities as copper, cadmium, iron, arsenic, antimony, nickel and cobalt. SAMUEL FIELD of London, England, proposes to lixiviate roasted zinc ores in the presence of ozone for the purpose of preventing the formation of iron salts. This is carried on in the presence of a catalyst, for example a manganese compound, and in a warm solution (80 to 100 deg. C.). Materials suitable for treating the solution in conjunction with ozone are manganese dioxide and hydrate; lead oxide and carbonate; zinc oxide, hydrate and carbonate. The result of this treatment is that any iron present is completely precipitated as ferric hydroxide, cobalt is thrown down as a higher insoluble oxide, and with these metals any arsenic and antimony present are also thrown down. Copper, nickel and cadmium are not, however, completely removed, but traces of these metals remaining may be removed by treatment with zinc fume. (1,331,334; Feb. 17, 1920.)

Process for Producing Refractory Compounds.—As is well known, domestic magnesite does not produce a satisfactory refractory, either in the grain form or when made into brick, without the addition of a bonding material. The process of producing a refractory, similar to Austrian magnesite, which consists in pulverizing and mixing calcined magnesite with a definite amount of an iron compound (sulphate, etc.) and silica to produce a material of approximately the following composition: magnesia, 86 per cent; iron oxide, 8 per cent, and silica, 6 per cent, after the mixture has been burned at a temperature of between 1,540 and 1,750 deg. C. has been patented by WILFRED M. HANDY of Spokane, Wash. (1,330,268; Feb. 10, 1920.)

Continuous Production of Ether.—Two forms of apparatus for the continuous production of ether are described by EMILE A. BARBET of Paris, France. The accompanying figure represents one type and will serve to demonstrate the principle, which is the same in each case. Alcohol is heated in *A*, the vapors passing through *B* to the bottom of the tower *C*, which is filled with acid-proof packing material. Sulphuric acid regenerated in the second step of the process also enters
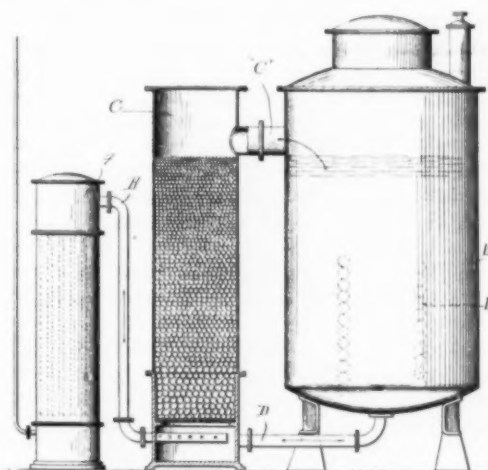
APPARATUS FOR CONTINUOUS PRODUCTION OF ETHER

the bottom of tower *C* through *D*. The alcohol vapor and sulphuric acid pass concurrently upward through tower *C*, reacting to form ethyl sulphuric acid, which overflows through *C* into the still *D*. This still is heated by the steam coil *E* and the ethyl sulphuric acid is decomposed with the production of ether and the regeneration of the sulphuric acid which passes out through *D*, thus completing the cycle. (1,328,258; assigned to E. Barbet & Fils & Cie., of Paris, France; Jan. 20, 1920.)

Synthetic Production of Cyanides and Nitrides.—Instead of forcing air through a heated mixture of carbon and alkali, AXEL R. LINDBLAD of Stockholm, Sweden, uses an electric furnace in which the air or nitrogen is sucked through the mass, thereby avoiding the necessity of heating to the reaction temperature large volumes of air which, in the former method, escape through the walls of the furnace. The cyanide volatilizes as formed and is drawn off with the exit gases. In the production of nitrides, the finished product is raked out through a discharge opening in the lower part of the furnace. (1,328,575; Jan. 20, 1920.)

Personal

M. LOUIS BOYER, representative of the firm of Gaillard, of Bezieres, France, recently visited the Burgess Laboratories, Madison, Wis.

J. A. BRETZ, chief chemist for the Bettendorf Co., Bettendorf, Pa., and president of the Chemists' Club of the Tri-Cities, is now chief chemist for the Southern Manganese Corporation at Anniston, Ala.

BRUCE K. BROWN has joined the staff of the Burgess Laboratories, Madison, Wis.

J. M. CLARK, formerly chief chemist for the Sherwin-Williams Chicago plant, is now superintendent for the Delora Smelting & Refining Co. at Delora, Ont., Canada.

LEVERETT DAVIS, consulting engineer, of Denver, Col., has been in New York on professional business.

W. M. DREW has been made manager of the Cleveland branch of Marden, Orth & Hastings Corporation, succeeding H. W. Galley.

Dr. FEDERICO GIOLITTI has sailed for Italy after a stay of several months in the United States, in the interests of his clients, G. Ansaldo Co., Stein & Co., and the Fiat Automobile Co.

Dr. JOHN CHARLES HESSLER has been appointed assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh, by Director Raymond F. Bacon. Dr. Hessler, who is now serving as president of the James Milliken University, Decatur, Ill., will enter upon his new duties at the close of the present academic year. As a member of the administrative staff of the Mellon Institute, Dr. Hessler will be in supervisory charge of certain of the researches in organic chemistry, a field in which he has specialized during the past twenty years.

G. M. HUNT, of the wood preservation section of the Forest Products Laboratory, recently gave a lecture before the Western Society of Engineers, Chicago, on the relation of the Forest Products Laboratory to the engineering profession.

Dr. DAVID KLEIN has resigned his commission as Major in the Sanitary Corps, U. S. Army, and accepted a position with Wilson & Co., Chicago, Ill.

DONALD M. LIDDELL, who has been on a professional trip in the West, has returned to New York.

JOHN L. MALM, metallurgical engineer, of Denver, Col., has been in New York on professional business.

ROBERT B. MILLER has entered upon his duties as state forester at the University of Illinois, Urbana, Ill.

R. B. RUDY, formerly consulting engineer with the Nitrate Division, Ordnance Department, has accepted a position with the Air Reduction Co., Inc., 120 Broadway, New York City.

FRANK L. SILSBEE, secretary of the National Association for the Protection of American Rights in Mexico, with headquarters in New York City, has been elected vice-president of the Federal Petroleum Co., with headquarters at Shreveport, La. He will have charge of the operations of that company in the Louisiana territory.

H. G. THIELE, formerly with the Oliver Continuous Filter Co., has accepted the position of superintendent in charge of the Boro Solvay potash plant of the Solvay Process Co., at Searles Lake, Cal.

FRED H. WAGNER has just returned from an extended trip in Europe, where he has been in the service of the Bartlett-Hayward Co., Baltimore, Md.

A. E. WHEELER has arrived in New York City after about a year's absence in England and the Belgian Congo, on work in connection with the new concentrating plant for Union Miniere du Haut Katanga.

B. B. THAYER, WILLIAM WRAITH and W. C. CAPRON expect to return early in April from Chile, where they have been inspecting the developments at the Andes mine and leaching plant.

Dr. WILLIS R. WHITNEY is to be the recipient of the Chandler medal as a recognition of his achievements in science. Dr. Whitney's subject will be "The Littlest Things of Chemistry." His lecture will be in Havemeyer Hall, Columbia University, New York City, the evening of April 27, 1920.

Obituary

ZEAR J. CHAMBERLAIN, of the Ludlow-Saylor Wire Co., St. Louis, Mo., died suddenly on March 20, in his forty-fifth year. He had been with this company since he was seventeen years old.

DIRK GEIJSBEEK MOLENAAR, of the Geijsbeek Engineering Co., Portland, Ore., died on March 11.

MELVIN B. NEWCOMB, aged thirty-one years, chief engineer of the rubber machinery department of the Wellman-Seaver-Morgan Co., died on Sunday, March 13, after a short illness, at his home, 742 West Ave., Akron, Ohio.

Current Market Reports

The Non-Ferrous Metal Market

New York, March 29, 1920.—The market remains quiet, with quotations as follows:

		Cents per l.b.
Copper, electrolytic		18.75
Aluminum, 98 to 99 per cent		31@32
Antimony, wholesale lots		11.00
Nickel, ordinary		43.00
Nickel, electrolytic		45.00
Tin, Straits, spot		61.50
Lead, New York, spot		9.00
Lead, E. St. Louis, spot		8.75
Zinc, spot, New York		8.75
Zinc, spot, E. St. Louis		8.50

OTHER METALS

Silver	oz.	$1.23½
Cadmium	lb.	1.40@1.50
Bismuth, (500 lb. lots)	lb.	2.50
Cobalt	lb.	1.50
Magnesium (f.o.b.) Niagara Falls	lb.	1.60
Platinum	oz.	150.00
Iridium	oz.	250.00
Palladium	oz.	150.00
Mercury	75 lb.	95.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per l.b.
Copper sheets, hot rolled	29.50
Copper sheets, cold rolled (over 14 oz.)	31.50
Copper bottoms	38.00
Copper rods	26.75
High brass wire and sheets	25.25
High brass rods	23.75
Low brass wire and sheets	27.25
Low brass rods	28.00
Brazed brass tubing	37.00
Brazed bronze tubing	41.75
Seamless copper tubing	32.00
Seamless bronze tubing	34.50
Seamless high brass tubing	33.00

SCRAP METALS

	Cents per l.b. Buying Price
Aluminum, cast scrap	22½@23½
Aluminum, sheet scrap	22@22½
Aluminum clippings	25½@26½
Copper, heavy machinery comp	15@15½
Copper, heavy and wire	13½@14½
Copper, light and bottoms	12@12½
Copper, heavy cut and crucible	15@15½
Brass, heavy	7@7½
Brass, casting	10@10½
Brass, light	5½@6½
No. 1 clean brass turnings	7½@7½
No. 1 comp. turnings	11½@11½
Lead, tea	5½@5½
Lead, heavy	7@7½
Zinc, scrap	4½@4½

The Iron and Steel Market

Pittsburgh, Pa., March 26, 1920.

The iron and steel markets in the past week have been rather bare of the new developments that have been making the weeks interesting for a long time past. Without there being clear-cut developments, however, there have been distinctly marked trends of importance. One of these is the great dwindling in the volume of prompt business, together with a tendency of delivery premiums to decrease. Another is the growing indisposition of buyers

to commit themselves for forward deliveries. In pig iron there has been a very quiet market, but that is not a particularly fresh item. In spots a little softening in pig-iron prices is noticed, but on the other hand prices seem to hold up moderately well for such a quiet market.

DELIVERY PREMIUMS

With a calm view of the whole market situation, one can hardly avoid the conclusion that the basis of the market is the Industrial Board prices which became effective March 21, 1919, and to which the United States Steel Corporation shows fully as strong adherence as at any time. A corollary is that all other and higher prices are premium prices; the premium being paid by reason of the earlier delivery involved as compared with the delivery the Steel Corporation could make, or by reason of the buyer not having an allotment by the Steel Corporation sufficient to cover his needs fully. For quite a while there was ground for a view that possibly there were two markets, Steel Corporation and independent, so that eventually one would have to meet the other. Such a view is certainly not tenable now. At any price above the Steel Corporation price one cannot sell far ahead.

The maximum range of delivery premiums has moved downward. The highest mill price obtained in the past few days for sheets has hardly been above 7c., when 10c. was done in a few instances late in February. The maximum on plates is now 4c., when 4.50c. was being obtained in not a few instances two or three weeks ago. The decline is not due to heavier offerings but rather to lighter market demand, this being due in turn to heavier receipts by consumers against purchases previously made.

As to prices of large independent producers who regularly sell some distance ahead, several of these producers are now committed to a definite policy of selling quarter by quarter, having a formal opening of books and naming prices just after the opening of one quarter for delivery in the succeeding quarter. Some sales are made in advance, however, perhaps at special prices, while next week or shortly thereafter there may be formal opening of books to all regular customers. Prices will not be above 3c. for bars, 3.10c. for shapes and 3.25c. for plates, and they may be lower, so that the market as to business of this description cannot be said to be advancing.

As to Steel Corporation prices, the only item this week is that sales of nails are again being made at the flat base price of $3.25. For a short time the corporation had been booking nails with the price item left open, the price to be the corporation price at time of shipment. This had led to an expectation that the corporation might make an exception of nails and announce a definite advance. There is a loss in nails, i.e., the profit is less in selling nails at $3.25 than in selling the plain wire at 3c., the corporation price.

PRODUCTION

Production of pig iron and steel has increased slightly, but is still under restriction by car shortage, limiting the movement of Connellsville coke and of coal to byproduct ovens, as well as of fuel coal to steel plants. By announcement of the President, price restrictions on coal and coke are lifted, effective April 1. Then there will be an open market, with higher prices than the Government limits. This will not of itself increase the total supplies of coal, but it will enable the steel industry to bid for coal, and as its ability and willingness to pay higher prices, for the purpose of securing full production, are virtually unlimited the supplies will be obtained, probably insuring a large increase in byproduct coke production and a full operation of steel mills in the near future.

PIG IRON DULL

There are fewer offerings of small prompt lots of pig iron in the local market, but there are still sufficient offerings to meet the limited demand. Consumers are but little interested in early deliveries, and in second half deliveries they are not interested at all. Consumers of pig iron are evidently covered ahead to the extent that they have sold their finished products, whether iron castings, steel castings or rolled steel; and as their finished products are not selling with much freedom at present, there is no occasion for extensive purchases of pig iron to be made. As to steel-making pig iron, it is quite plain that there is no promise now of steel mills being able to sell finished steel products for second half delivery that would justify the payment of prices now asked for basic or bessemer iron. Pig iron, in its spectacular advance, was unable to force the steel market up sufficiently to make a harmonious relation. The market is quotable, largely nominal, at about $42 for bessemer, $41.50 for basic and $42 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being $1.40.

FERRO-ALLOYS

Spiegeleisen is quiet at $57@$60. Ferromanganese is firm at the recently advanced price, $180, delivered, being minimum for second half, with some producers talking of $200. Prompt has sold at well above $200, but only in small lots. Ferrosilicon is quotable at $80@$81, delivered, for 50 per cent and $140 for 75 per cent. Bessemer ferrosilicon is $59.50 for 10 per cent, $62.80 for 11 per cent and $66.10 for 12 per cent, f.o.b. furnaces at Jackson and New Straitsville, Ohio.

Chemical and Allied Industrial Markets

New York, March 27, 1920.

The overtaxed chemical market has been firmer, if anything, during the past week than it was in the previous report. Supplies are not being replenished by producers at a rate sufficient to meet the demand and spot material on practically all items is nominal. Price advances during the week have been brought about mainly by the decreasing amount of supplies being received from producers, who are sold up from two to four months ahead on the main items on the list. The shortage of steel drums and containers has further hindered shipment from the producer to the consumer.

GENERAL CHEMICALS

Under the pressure of heavy foreign demand *aluminum sulphate*, commercial, advanced to 2¼@3½c. per lb. with supplies on hand very light. Iron free has remained firm at 2¾@3¾c. per lb. Supplies on both grades of *sal ammoniac* are very scarce and the spot market is practically nominal, with white quoted at 15@18c. per lb., while gray is listed from 13@14½c. per lb. The stocks of English material in this market are now practically exhausted and a still further advance by domestic manufacturers is looked for. *Barium chloride* is firmer than at the time of the last report. Sales have been reported as high as $155@$160 per ton, but this is not to be taken as market price, as consumers under pressure of necessity will pay most any price. Manufacturers are sold ahead so far that relief is not expected before the end of the summer. *Calcium hypochlorite* remains steady, ranging from $3.50@$4.50 per cwt., according to the amount. A rise on this item is looked for in some quarters, owing to shortening of supplies being received from producers. Prices on *carbon bisulphide* have been advanced from 6c. as low mark on car lots to 7@8c. per lb. Quotations on *nickel salt* are practically nominal, as there is very little material to be had, 16@17½c. for the single and 14@15c. per lb. for the double.

Caustic potash is very scarce and at present the spot market is exhausted of supplies. Prices range from 25@28c. on car lots, according to quality, while dealers are asking from 30@35c. per lb. for spot with very little material to be found. *Soda ash* is in the control of the dealers, as they are the only ones who have any material to offer. Sales on the light have been reported as high as $3.50 per cwt. *Sodium nitrite* is somewhat easier than it was last week, spot material being offered at 35@45c. per lb., but the acute shortage of two weeks ago is not relieved and it will be some time before this item is back to normal.

COAL-TAR PRODUCTS

General conditions remain unchanged, with the spot market tighter in supplies and firmer in price. Producers are not able to cope with the demand. Many of the items on

the list are nominal, as there is no material to be had at the prices quoted. One large factor in *naphthalene* has withdrawn from this market, as he is sold ahead into mid-summer. The price has advanced from 6@8c. to 8@9c. per lb., while flake is firmer at 7½@8½c. per lb. *Solvent naphtha*, pure water white, jumped to 25@31c. from 27c. per gal. of last week. *H acid* is being sold by dealers at $1.75@$1.90 per lb., with very little material available at these prices. The demand on *cresol* has been steady during the week and the price held firm at 16@18c. per lb.

WAXES

There has been the usual amount of business in this market during the week. The only fact worthy of comment is continued shortage of the *paraffine* grades. Foreign buyers are still active inquirers on these items.

NAVAL STORES

There has been no activity in this market during the past week. Prices on *turpentine* have gone up, but there is no material available at any price. Current quotations range from $2.35@$2.40 per gal. with a steady increase looked for until relief can be received from Savannah.

Rosins are in the same condition, all prices being nominal. It is reported that there are several ships on the way from the South, but it may be impossible to unload them because of the longshoremen's strike.

CRUDE RUBBER

This market during the past week has remained unchanged. The rate of exchange is the controlling factor at present. If the rate goes up sellers withdraw their low offerings; if the rate goes down buyers refuse to take any active part. Outside of the bare necessities, consumers are not in the market to any extent.

OILS

The increasing shortage of *linseed oil* has caused a strengthening in this market and no immediate relief is in sight from the Argentine crop, as it is the opinion of many that the new seed will not be able to meet the demand. Current quotations are: $1.84 raw car lots and $1.87 for boiled, tank cars. *Cottonseed* is firm at former prices, crude being quoted at 18@19c. per lb., while winter yellow is listed at 22@24½c. per lb.

MISCELLANEOUS MATERIALS

This branch of the market has held firm throughout during the past week, *barytes* being the most active item on the list. A rise in price is looked for shortly. Current quotations: Domestic white floated, $35@$40, and off color, $25@$30 per ton.

Chicago, March 24, 1920.

Comparatively quiet markets with prices unchanged and firm rule in all branches of the local chemical trade with the exception of alkalis, vegetable oils and naval stores. *Alkalis* continue under heavy demand from exporters and every day sees a slight boost in prices. The same is true of *naval stores*, but *vegetable oils* continue to be very weak. Business of the past two weeks has been marked by no spectacular feature.

Conditions brought about by the shortage in *turpentine* are forcing many industries which formerly used pure gum spirits to use wood turpentine. This product, although not equal in purity to the pure gum grade, is being substituted and can be produced in unlimited quantity and is quoted at a cheaper price. The principal disadvantage of this substitution is the offensive smell of wood turpentine. If present conditions remain unchanged, it is possible that the industrial arts will, in time, all come to the use of wood turpentine, leaving the gum spirits for use in paints.

HEAVY CHEMICALS

As has been the case for several weeks, the demand for alkali products has greatly exceeded supply. Spot stocks are close to the vanishing point. On what is purely a sellers' market, *solid caustic* is now bringing $6.25 per cwt. f.o.b. works in cars, with a half cent higher on small spot transactions. The *granulated* commands 6c. at the works. *Soda ash*, in sympathy with the other items of this classi-

fication, is quoted at $3 per cwt., f.o.b. works. *Bleaching powder*, quoted two weeks ago at $3.50, now brings 4@5c. per lb., depending on how badly it is needed. *Sal soda*, in cars, is quoted at $1.50 per cwt., while jobbers are asking as high as $2.25 in small lots.

On the strength of anticipated receipts from abroad, recent panicky conditions in *sodium nitrite* have partially subsided. Current transactions are at 35c. per lb. While this seems high, it will take a considerable increase in supply over that now available to reduce it materially. Only nominal quotations are available on all grades of *alcohol*. A few small actual transactions have occurred in denatured, 180 proof, at $1 a gal. *Formaldehyde* continues to bring whatever the buyer can offerd, actual quotation being around $1 per lb. *Sodium bichromate* shows further reduction, now going for 35c. per lb., spot, in small quantity.

White sal ammoniac, the shortage of which is said to be due to transportation troubles, remains high, current price being 19@20c. per lb. for immediate delivery. Strong lead market has developed high prices in lead products, *acetate* being firm at 14½c. per lb. and *arsenate*, powdered, at 30@31½c. per lb.

The most important factor in connection with *acids* is the difficulty in securing containers, both drums and tanks, in which to make shipment. Firmness in price is noted, with *boric* at 16c. in cars and *oxalic* at 44@47c. in cars. Stocks of *hydrofluoric* seem to be seriously depleted, current quotation being 8@8½c. per lb.

COAL-TAR PRODUCTS

Conditions are practically unchanged since last reported. The steady improvement in supply continues and a slight reaction in price has resulted. *Benzol* and *toluol* are firm at 28c. in carloads. *Anilines* are some easier, the *oil* going at 32@35c. per lb. and the *salts* at 42@50c. per lb., with the latter figure prevailing in most cases. *Dimethylaniline* is being quoted at $1.60 per lb., but this quotation is purely nominal, no stocks being on hand. *Salicylic acid* is slightly under previous quotation. Present figures for technical grade, 47c.; for U. S. P., 57@58c. per lb. While no change has recently been noted in *naphthalene*, a decided firmness is noted due to dwindling stock. The ruling price for *flake* from stock is 8c. per lb., and 10c. for balls.

VEGETABLE OILS

This market continues weak. With buyers controlling the market, prices remain at a low level. *Cocoanut oil* in sellers' tanks, f.o.b. coast, is still quoted at 17c., and *soya bean oil* at 16@16½c. The *linseed oil* market remains very strong; transportation troubles, lack of imports of South American seed and uncertainty as to the extent of the new crop tend to a bull market. Present quotation in tank cars f.o.b. Chicago is $1.66@$1.71 per gal. In barrels, in quantity up to five, jobbers are getting $2.05.

FLOTATION OILS—NAVAL STORES

Turpentine continues to soar. Actual stocks on hand are known to aggregate only about 20 per cent of the normal for this time of year and the coming crop is an unknown factor. Those claiming to be in a position to know foretell a very scant crop, which means that present scarcity may even be made worse. Every few days sees a fresh advance and only a fraction of the demand is being supplied. Price in cars f.o.b. Chicago is $2.38@$2.40, and in barrels $2.52 per gal. No price change is noted on *pine oil*, but existing quotations of $1.60 for 0.933 pure steam distilled and $1.55 for destructively distilled are nominal, as demand so greatly exceeds supply. *Rosin* and *pine tar oil* show no material change in price, but demand is less.

FERTILIZERS

The expected slump has occurred. Stocks are now plentiful and calls from all sources are becoming few. Most seasonal demands are supplied and manufacturers are running to store stocks for future requirements. Ruling prices on *high-grade blood* are: For ground, $8.25@$8.40 per cwt.; on *tankage*, for high-grade ground, $7.65@$7.90 per cwt., and for low-grade ground, $7@$7.25 per cwt.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	—	$0.60 – $0.65
Acetone	lb.	$0.13 – $0.15	.16 – .18
Acid, acetic, 28 per cent	cwt.	2.75 – 3.00	3.00 – 3.75
Acetic, 56 per cent	cwt.	6.00 – 6.50	7.00 – 7.50
Acetic, glacial, 99¼ per cent, arboy	cwt.	12.00 – 14.00	15.00 – 15.50
Boric, crystals	lb.	.14½ – .15½	.15½ – .16½
Boric, powder	lb.	.14½ – .15	.15 – .16
Hydrochloric	lb.	.08 –	.09 – .10
Hydrofluoric, 52 per cent	lb.	.12 – .12½	.14 –
Lactic, 44 per cent tech	lb.	.11 – .11½	.12 – .16
Lactic, 22 per cent tech	lb.	.05 – .06	.05½ – .07
Molybdic, C. P.	lb.	—	4.25 – 5.00
Nitric, 40 deg.	lb.	.06 – .07	.07½ – .08½
Nitric, 42 deg.	lb.	.06½ – .07½	.08 – .09½
Oxalic, crystals	lb.	.35 – .42	.43 – .48
Phosphoric, Ortho, 50 per cent solution	lb.	.24 –	—
Picric	lb.	.30 – .35	.40 – .50
Pyrogallic, resublimed	lb.	2.50 – 2.55	2.60 – 2.65
Sulphuric, 60 deg., tank cars	ton	17.50 – 22.00	—
Sulphuric, 60 deg., drums	ton	—	—
Sulphuric, 66 deg., tank cars	ton	22.00 – 25.00	—
Sulphuric, 66 deg., drums	ton	—	—
Sulphuric, 66 deg., carboys	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	27.00 – 30.00	32.00 –
Sulphuric, fuming, 20 per cent (oleum) drums	ton	32.00 –	34.00 –
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	35.00 –	40.00 –
Tannic, U. S. P.	lb.	—	1.35 – 1.45
Tannic (tech.)	lb.	—	.60 – .80
Tartaric, crystals	lb.	—	.69 – .74
Tungstic, per lb. of WO	lb.	—	1.20 – 1.40
Alcohol, Ethyl (nominal)	gal.	5.10 – 5.50	6.00 – 7.00
Alcohol, Methyl (nominal)	gal.	2.35 – 2.75	—
Alcohol, denatured, 188 proof (nominal)	gal.	—	1.00 – 1.05
Alcohol, denatured, 190 proof (nominal)	gal.	—	.98 – 1.02
Alum, ammonia lump	lb.	.04 – .05	.05½ – .06
Alum, potash lump	lb.	.08 – .08½	.09 – .09½
Alum, chrome lump	lb.	.15 – .16	.18 – .20
Aluminum sulphate, commercial	† lb.	.01½ – .02	.02½ – .03½
Aluminum sulphate, iron free	† lb.	.02½ – .03	.03½ – .03½
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.08½ – .10½	.11 – .12
Ammonia, anhydrous, cylinders (100-150 lb.) lb.		.33 – .35	.35 – .37
Ammonium carbonate, powder	lb.	.16 – .16½	.17 – .17½
Ammonium chloride, granular (white salammoniac) (nominal)	† lb.	.15 – .15½	.16 – .18
Ammonium chloride, granular (gray salammoniac)	† lb.	.13 – .13½	.14 – .14½
Ammonium nitrate	lb.	.10 – .12	—
Ammonium sulphate	lb.	.05 –	.06 –
Amylacetate	gal.	—	3.65 – 3.75
Arsenic, oxide, lumps (white arsenic)	lb.	—	.10½ – .11
Arsenic, sulphide, powdered (red arsenic)	lb.	.23 – .24	—
Barium (nominal)	† ton	125.00 – 135.00	140.00 – 150.00
Barium dioxide (peroxide)	lb.	.23 – .27	.28 – .30
Barium nitrate	lb.	.18 – .19	.20 – .22
Barium sulphate (precip.) (blanc fixe)	lb.	.03 – .03½	.05½ – .06
Bleaching powder (see calcium hypochlorite)			
Blue vitriol (see copper sulphate)		—	—
Borax (see sodium borate)		—	—
Brimstone (see sulphur, roll)		—	—
Bromine	lb.	.85 – .95	—
Calcium acetate	cwt.	2.00 – 2.05	2.10 –
Calcium carbide	lb.	—	.04½ – .05
Calcium chloride, fused, lump	ton	20.00 – 25.00	30.00 – 40.00
Calcium chloride, granulated	lb.	.01½ – .01½	.02 – .02½
Calcium hypochlorite (bleaching powder)	† cwt.	3.50 – 3.75	4.00 – 4.50
Calcium peroxide	lb.	—	1.50 – 1.70
Calcium phosphate, monobasic	lb.	—	.75 – .80
Calcium sulphate, pure	lb.	—	.25 – .30
Carbon bisulphide	† lb.	.07 – .08	.09 – .10
Carbon tetrachloride, drums	lb.	.10½ – .11	.12 – .15½
Carbonyl chloride (phosgene)	lb.	—	.80 – 1.05
Caustic potash (see potassium hydroxide)		—	—
Caustic soda (see sodium hydroxide)		—	—
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.06 – .07	.08 – .09
Chloroform	lb.	.28 – .29	.30 – .31
Cobalt oxide	lb.	—	2.00 – 2.05
Copperas (see iron sulphate)		—	—
Copper carbonate, green precipitate	lb.	.27 – .28	.29 – .31
Copper cyanide	lb.	—	.65 – .70
Copper sulphate, crystals	lb.	.08½ – .09	.09 – .09½
Cream of tartar (see potassium bitartrate)			
Epsom salt (see magnesium sulphate)			
Formaldehyde, 40 per cent (nominal)	lb.	.38 – .40	.60 – .80
Glauber's salt (see sodium sulphate)			
Glycerine	lb.	—	.24½ – .26
Iodine, resublimed	lb.	—	4.10 – 4.30
Iron oxide, red	lb.	—	.03 – .20
Iron sulphate (copperas)	cwt.	1.20 –	1.25 – 1.75
Lead acetate, normal	lb.	.12 – .13	.14 – .23
Lead arsenate (paste)	lb.	—	.13 – .17
Lead nitrate, crystals	lb.	—	.70 – .80
Litharge	lb.	.14 – .15	.15½ – .16
Lithium carbonate	lb.	—	1.50 –
Magnesium carbonate, technical	lb.	—	.13 – .14½
Magnesium sulphate, U. S. P.	100 lb.	3.40 – 3.55	3.60 – 3.75
Magnesium sulphate, commercial	100 lb.	3.00 – 3.10	3.10 – 3.25
Nickel salt, double	† lb.	.14 –	.15 –
Nickel salt, single	† lb.	.16 – .17	.17½ –
Phosgene (see carbonyl chloride)			
Phosphorus, red	lb.	—	.60 – .65
Phosphorus, yellow	lb.	—	.35 – .37
Potassium bichromate	lb.	.32 – .33	.34 – .37
Potassium bitartrate (cream of Tartar)	lb.	—	.56 – .60
Potassium bromide, granular	lb.	—	.50 – .65
Potassium carbonate, U. S. P.	lb.	.60 –	.65 – .70
Potassium carbonate, crude	lb.	.26 – .27	.28 – .30
Potassium chlorate, crystals	lb.	.16 – .20	.21 –
Potassium hydroxide (caustic potash)	† lb.	.25 – .28	.30 – .35
Potassium iodide	lb.	—	3.35 – 3.60
Potassium nitrate	lb.	.19 –	.21 –
Potassium permanganate		—	$0.65 – $0.95

† (See New York market letter).

		Carlots	Less Carlots
Potassium prussiate, red	lb.	1.00 – 1.05	1.10 – 1.20
Potassium prussiate, yellow	lb.	.34 – .36	.40 – .70
Potassium sulphate	ton	225.00 –	—
Rochelle salts (see sodium potas. tartrate)		—	—
Salammoniac (see ammonium chloride)		—	—
Sal soda (see sodium carbonate)		—	—
Salt cake	ton	21.00 – 22.00	—
Silver cyanide (nominal)	oz.	—	1.25 –
Silver nitrate (nominal)	oz.	—	.77 – .82½
Soda ash, light	†100 lb.	2.50 – 2.60	— 3.50
Soda ash, dense	† 100 lb.	2.70 – 2.75	— 3.55
Sodium acetate	lb.	.06½ – .07	.07 – .08
Sodium bicarbonate	100 lb.	2.40 –	2.75 – 3.00
Sodium bichromate	lb.	.33 – .34	.35 – .36
Sodium bisulphate (nitre cake)	ton	7.00 – 7.50	8.00 – 10.00
Sodium bisulphite Powered	lb.	.05½ – .06½	.07 – .07½
Sodium borate (borax)	lb.	.08½ – .08½	.09 – .09½
Sodium carbonate (sal soda)	100 lb.	1.25 – 1.35	1.40 – 1.50
Sodium chlorate	lb.	.10 –	.12 – .14
Sodium cyanide, 96-98 per cent	lb.	.24 – .25	.26 – .27
Sodium fluoride	lb.	.14 –	.15 – .16
Sodium hydroxide (caustic soda)	100 lb.	5.00 – 6.00	6.10 – 6.25
Sodium hyposulphite	lb.	—	.03 – .04
Sodium molybdate	lb.	2.50 –	3.25½ –
Sodium nitrate	100 lb.	3.00 – 3.25	3.75 – 4.00
Sodium nitrite	† lb.	—	.35 – .45
Sodium peroxide, powdered	lb.	—	.30 – .32
Sodium phosphate, dibasic	lb.	.03½ – .04½	.04½ – .05
Sodium potassium tartrate (Rochelle salts)	lb.	.40 – .42	.43 – .45½
Sodium prussiate, yellow	lb.	.23 – .29	.30 – .40
Sodium silicate, solution (40 deg.)	lb.	.01½ – .02	.02 – .02½
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.04 – .05
Sodium sulphate, crystals (Glauber's salt)	cwt.	1.15 – 1.50	1.60 – 2.00
Sodium sulphide, crystal, 60-62 per cent (conc) lb.		—	.05 – .06
Sodium sulphite, crystals	lb.	.03½ –	.04 – .06
Strontium nitrate, crystals	lb.	.25 –	.28 –
Sulphur chloride	lb.	.05½ –	.06 –
Sulphur, crude	ton	22.00 –	—
Sulphur dioxide, liquid, cylinders	lb.	.09 –	.10 – .12
Sulphur (sublimed), flour	100 lb.	3.35 –	3.40 – 3.65
Sulphur, roll (brimstone)	100 lb.	3.20 –	3.30 – 3.40
Tin bichloride (stannous)	lb.	.42½ –	.46 – .50
Tin oxide	lb.	.50 – .60	.65 –
Zinc carbonate, precipitate	lb.	—	.20 –
Zinc chloride, gran.	lb.	.13 –	.13½ – .15
Zinc cyanide	lb.	.49 –	.50 – .60
Zinc dust	lb.	.11½ – .12½	.13 – .15
Zinc oxide, U. S. P.	lb.	—	.19 – .21
Zinc sulphate	lb.	.03½ – .03½	.04 – .04½

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha naphthol, crude	lb.	$1.00	—	$1.10
Alpha naphthol, refined	lb.	1.40	—	1.60
Alpha naphthylamine	lb.	.40	—	.50
Aniline oil, drums extra	lb.	.34	—	.45
Aniline salts	lb.	.42	—	.48
Anthracine, 80% in drums (100 lb.)	lb.	.75	—	1.00
Benzaldehyde (f.f.c.)	lb.	2.00	—	2.10
Benzidine, base	lb.	1.25	—	1.35
Benzidine, sulphate	lb.	1.00	—	1.15
Benzoic acid, U.S.P.	lb.	.90	—	1.10
Benzoate of soda, U.S.P.	lb.	.80	—	1.00
Benzol, pure, water-white, in drums (100 lb.)	gal.	.27	—	.36
Benzol, 90%, in drums (100 lb.)	gal.	.25	—	.31
Benzyl chloride, 95-97%, refined	lb.	.35	—	.40
Benzyl chloride, tech	lb.	.25	—	.35
Beta naphthol benzoate	¶ lb.	.50	—	.65
Beta naphthol, sublimed	lb.	.70	—	.90
Beta naphthol, tech	lb.	.45	—	.55
Beta naphthylamine, sublimed	lb.	2.25	—	2.35
Cresol, U. S. P., in drums (100 lb.)	† lb.	.16	—	.18
Ortho-cresol, in drums (100 lb.)	lb.	.23	—	.25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95	—	1.10
Cresylic acid, 95-97%, dark, in drums	gal.	.85	—	1.00
Cresylic acid, 50%, first quality, drums	gal.	.60	—	.70
Dichlorbenzol	lb.	.07	—	.10
Diethylaniline	lb.	1.40	—	1.50
Dimethylaniline (nominal)	lb.	.95	—	1.50
Dinitrobenzol	lb.	.26	—	.37
Dinitrochlorbenzol	lb.	.25	—	.30
Dinitronaphthaline	lb.	.45	—	.55
Dinitrophenol	lb.	.32	—	.36
Dinitrotoluol	lb.	.38	—	.45
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38	—	.40
Diphenylamine (nominal)	lb.	.55	—	.65
H-acid (nominal)	† lb.	1.75	—	1.90
Metaphenylenediamine	lb.	1.15	—	1.80
Monochlorbenzol	lb.	.12	—	.15
Monoethylaniline	lb.	1.50	—	1.75
Naphthaline crushed, in bbls. (250 lb.)	† lb.	.08	—	.09
Naphthaline, flake	lb.	.07	—	.08
Naphthaline, balls	lb.	.08½	—	.10
Naphthionic acid, crude	lb.	.70	—	.85
Nitrobenzol	lb.	.14	—	.19
Nitro-naphthaline	lb.	.30	—	.35
Nitro-toluol	lb.	.20	—	.30
Ortho-amidophenol	lb.	3.75	—	4.25
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-nitro-phenol	lb.	.80	—	1.25
Ortho-nitro-toluol	lb.	.25	—	.40
Ortho-toluidine	lb.	.25	—	.45
Para-amidophenol, base	lb.	2.50	—	3.50
Para-amidophenol, HCl	lb.	2.50	—	3.25
Para-dichlor-benzol	lb.	.12	—	.18
Paranitraniline	lb.	1.00	—	1.35
Para-nitro-toluol	lb.	1.35	—	1.50
Paraphenylenediamine	lb.	2.15	—	3.00
Paratoluidine	lb.	1.75	—	2.50
Phthalic anhydride	lb.	.65	—	.75
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12	—	.25
Pyridin	gal.	2.00	—	2.50
Resorcin, technical	lb.	4.25	—	4.50
Resorcin, pure	lb.	6.25	—	6.75
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.45	—	.50
Salicylic acid, U. S. P.	lb.	.55	—	.60
Salol	lb.	.90	—	1.00

Solvent naphtha, water-white, in drums, 100 gal.	†gal.	$0.25	—	$0.31
Solvent naphtha, crude, heavy, in drums, 100 gal.	†gal.	.19	—	.24
Sulphanilic acid, crude	lb.	.25	—	.30
Toluidine	lb.	1.70	—	2.50
Toluidine, mixed	lb.	.45	—	.55
Toluol, in tank cars	gal.	.28	—	....
Toluol, in drums	gal.	.29	—	.32
Xylidine, drums, 100 gal.	lb.	.44	—	.50
Xylol, pure, in drums	gal.	.37	—	.45
Xylol, pure, in tank cars	gal.	.35	—	....
Xylol, commercial, in drums, 100 gal.	gal.	.37	—	.45
Xylol, commercial, in tank cars	gal.	.23	—	.27

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	† lb.	$0.38	—	$0.40
Beeswax, refined, light	† lb.	.40	—	.41
Beeswax, white pure	lb.	.63	—	.68
Carnauba, No. 1. (nominal)	lb.	.80	—	.88
Carnauba, No. 2, regular (nominal)	lb.	.60	—	.70
Carnauba, No. 3, North Country (nominal)...†	lb.	.43	—	.45
Japan	lb.	.17	—	.20
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	....	—	.10
Paraffine waxes, crude, scale 124-126 m.p.	lb.	....	—	.10½
Paraffine waxes, refined, 118-120 m.p.	lb.	....	—	.08
Paraffine waxes, refined, 128-130 m.p.	lb.	.11	—	.11½
Paraffine waxes, refined, 133-135 m.p.	lb.	....	—	.13
Paraffine waxes, refined, 135-137 m.p.	lb.	....	—	.14
Stearic acid, single pressed	lb.	.26	—	.27
Stearic acid, double pressed	lb.	.32	—	.29
Stearic acid, triple pressed	lb.	.32	—	.33

NOTE—Quotations on paraffine waxes are nominal.

Flotation Oils

All prices are f.o.b. New York, unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp. gr., 0.930-0.940	gal.			$1.65
Pine oil, pure, dest. dist.	gal.			....
Pine tar oil, ref., sp. gr. 1.025-1.035	gal.			.48
Pine tar oil, crude, sp.gr.1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.			.47
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.			.85
Pine tar, ref., thin, sp. gr., 1.080-1.960	gal.			.38
Turpentine, crude, sp. gr., 0.900-0.970	gal.			1.75
Hardwood oil, f.o.b. Mich., sp. gr., 0.960-0.990	gal.			.35
Pinewood creosote, ref.	gal.			.52

Naval Stores

The following prices are f.o.b., New York, for carload lots.

Rosin B-D, bbl.	†280 lb.	$17.95	—	$18.25
Rosin E-I	280 lb.	18.75	—	19.00
Rosin K-N	280 lb.	19.45	—	21.00
Rosin W. G.-W. W.	280 lb.	22.00	—	22.50
Wood rosin, bbl.	280 lb.	15.50	—	17.50
Spirits of turpentine	gal.	....	—	2.35
Wood turpentine, steam dist.	gal.	....	—	2.25
Wood turpentine, dest. dist.	gal.	....	—	2.10
Pine tar pitch, bbl.	200 lb.	8.40	—	8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	14.50	—	15.00
Retort tar, bbl.	500 lb.	15.00	—	15.50
Rosin oil, first run	gal.	.92	—	.95
Rosin oil, second run	gal.	.94	—	.97
Rosin oil, third run	gal.	1.10	—	1.15
Rosin oil, fourth run	gal.	1.17	—	1.18

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.		$0.33½
70-72 deg., steel bbls. (85 lb.)	gal.		.31½
68-70 deg., steel bbls. (85 lb.)	gal.		.30½
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.		.23½

Crude Rubber

Para—Upriver fine	lb.	$0.40½	—	$0.42
Upriver coarse	lb.	.30½	—	.32
Upriver caucho ball	lb.	.32½	—	.33
Plantation—First latex crepe	lb.	.47½	—	.50
Ribbed smoked sheets	lb.	.47½	—	.48½
Brown crepe, thin, clean	lb.	.45	—	....
Amber crepe No. 1	lb.	.46	—	.47

Oils

VEGETABLE

The following prices are f.o.b., New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.19	—	$0.20
Castor oil, AA, in bbls.	lb.	.20	—	.23
China wood oil, in bbls.	lb.	.24½	—	.25½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.18	—	.19½
Cocoanut oil, Cochin grade, in bbls.	lb.	.20½	—	.23
Corn oil, crude, in bbls.	lb.	.18	—	.19
Cottonseed oil, crude (f.o.b. mill)	lb.	.17½	—	.18
Cottonseed oil, summer yellow	lb.	.19½	—	.20½
Cottonseed oil, winter yellow	lb.	.22	—	.24½
Linseed oil, raw, car lots	gal.	1.84	—	....
Linseed oil, raw, tank cars	gal.	1.77	—	....
Linseed oil, boiled, car lots	gal.	1.87	—	....
Olive oil, commercial	gal.	2.50	—	3.00
Palm, Lagos	lb.	.16	—	.16½
Palm, bright red	lb.	.15½	—	.17½
Palm, Niger	lb.	.15	—	.17½
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.20½	—	.22
Peanut oil, refined, in bbls.	lb.	.27	—	.28
Rapeseed oil, refined in bbls.	gal.	1.70	—	1.78
Rapeseed oil, blown, in bbls.	gal.	1.80	—	1.85
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.18½	—	.23
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.15½	—	.20

FISH

Winter pressed Menhaden	gal.	$1.17	—	$1.18
Yellow bleached Menhaden	gal.	1.20	—	1.22
White bleached Menhaden	gal.	1.23	—	1.24
Blown Menhaden	gal.	1.30	—	1.35

† (See New York market letter)

Miscellaneous Materials

All Prices f.o.b., N. Y.

Barytes, domestic, white, floated	ton	$35.00	—	$40.00
Barytes, off color	ton	20.00	—	25.00
Blanc fixe, dry	lb.	.04½	—	.05½
Blanc fixe, pulp	ton	30.00	—	50.00
Casein	lb.	....	—	....
Chalk, English, extra light	lb.	.05	—	.07
Chalk, English, light	lb.	.04½	—	.06
Chalk, English, dense	lb.	.04	—	.05
China clay (Kaolin), imported, lump	ton	25.00	—	35.00
China clay (Kaolin), imported, powdered	ton	30.00	—	60.00
China clay (Kaolin), domestic, lump	ton	10.00	—	20.00
China clay (Kaolin), domestic, powdered	ton	25.00	—	40.00
Feldspar (nominal)	ton	13.50	—	18.00
*Fluor spar, acid grade, lump, f.o.b. mines	net ton	30.00	—	45.00
*Fluor spar, acid grade, ground, f.o.b. mines	net ton	52.00	—	57.00
Fuller's earth, domestic, powdered	ton	25.00	—	30.00
Fuller's earth, imported, powdered	ton	35.00	—	40.00
Graphite, crucible, 85% carbon content	lb.	....	—	.07½
Graphite, crucible, 86% carbon content	lb.	....	—	.08
Graphite, crucible, 87% carbon content	lb.	....	—	.07
Graphite, crucible, 88% carbon content	lb.	....	—	.08
Graphite, crucible, 89% carbon content	lb.	....	—	.08½
Graphite, crucible, 90% carbon content	lb.	....	—	.09½
Graphite, crucible, 91% carbon content	lb.	....	—	.08
Graphite, crucible, 92% carbon content	lb.	....	—	.09½
Graphite, crucible, plus 92%	lb.	....	—	.12½
Pumice stone, imported	lb.	.03	—	.06
Pumice stone, domestic	lb.	.02½	—	....
Shellac, orange, fine	lb.	1 45	—	....
Shellac, orange, superfine	lb.	1.50	—	1.55
Shellac, A. C. garnet	lb.	1.25	—	1.30
Soapstone	ton	15.00	—	25.00
Talc, domestic	ton	20.00	—	60.00
Talc, imported	ton	60.00	—	70.00

*Nominal

Refractories

Following prices are f.o.b. works:

Chrome brick	net ton	75-80 at Chester, Penn.
Chrome cement	net ton	45-50 at Chester, Penn.
Clay brick, 1st quality fireclay	1,000	38-45 at Clearfield, Penn.
Clay brick, 2nd quality	1,000	33-35 at Clearfield, Penn.
Magnesite, dead burned	net ton	50-55 at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80-85 at Chester, Penn.
Silica brick	1,000	45-50 at Mt. Union, Penn.

Ferro-Alloys

All Prices f.o.b. works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200.00	—	$250.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon	lb.	.20	—	.21
Ferro-chrome, per lb. of Cr. contained, 2-4% carbon	lb.	.21	—	.22
Ferro-manganese, 70-80% Mn	gross ton	180.00	—	225.00
Spiegeleisen, 16-20% Mn	gross ton	50.00	—	70.00
Ferro-molybdenum, per lb. of Mo	lb.	2.25	—	2.75
Ferro-silicon, 50%	gross ton	80.00	—	90.00
Ferro-silicon, 75%	gross ton	150.00	—	200.00
Ferro-silicon, 10-15%	gross ton	60.00	—	70.00
Ferro-tungsten, 70-80%, per lb. of contained W.	lb.	.90	—	1.10
Ferro-uranium, 35-50%, of U	lb.	7.00	—	....
Ferro-vanadium, 30-40% per lb. of contained V	lb.	6.50	—	7.50

Ores and Semi-finished Products

All Prices f. o. b. Mines

Chrome ore, 35-40%, Cr_2O_3	unit	$0.70	—	$0.85
Chrome ore, 48% and over	unit	1.00	—	1.25
*Coke, foundry, f.o.b. ovens	net ton	7.00	—	....
*Coke, furnace, f.o.b. ovens	net ton	6.00	—	....
Petroleum coke, refinery, Atlantic seaboard	net ton	....	—	14.00
Fluor spar, gravel, f.o.b. mines	net ton	....	—	25.00
Manganese ore, 45% Mn and over	unit	.75	—	.85
Manganese ore, chemical (MnO_2)	gross ton	80.00	—	90.00
Molybdenite, 85% MoS_2, per lb. of MoS_2	lb.	.75	—	.85
Tungsten, Scheelite, 60% WO_3 and over, per unit of WO_3	unit	7.00	—	10.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3	unit	6.25	—	6.75
Uranium oxide, 96%	lb.	2.75	—	3.00
Vanadium pentoxide, 99%	lb.	6.00	—	....
Pyrites, foreign, lump	unit	.17	—	....
Pyrites, foreign, fine	unit	.17	—	....
Pyrites, domestic, fine	unit	.16	—	.17½
Ilmenite, 52% TiO_2	lb.	.02	—	....
Rutile, 95% TiO_2	lb.	.11	—	....
Carnotite, minimum 2% U_3O_8, per lb. of U_3O_8	lb.	2.75	—	3.00
Zircon, washed, iron free	lb.	.10	—	....
Monazite, per unit of ThO_2	unit	42.00	—	....

*Government prices.

Structural Steel

Mill, Pittsburgh

Beams and channels, 3 to 15-in.	100 lb.	$2.45
Angles, 3 to 6-in., ¼-in. thick	100 lb.	2.45
Tees, 3-in. and larger	100 lb.	2.45
Plates	100 lb.	2.65
Rivets, structural, ¾-in. and larger	100 lb.	4.20
Rivets, conehead for boilers, ¾-in. and larger	100 lb.	4.30
Sheets, No. 28 black	100 lb.	4.85
Sheets, No. 10 blue annealed	100 lb.	4.00
Sheets, No. 28 galvanized	100 lb.	6.20

For painted corrugated sheets, add 30c. per 100 lb. for 25 to 28 gage; 25c. for 19 to 24 gage; for galvanized corrugated sheets, add 15c., all gages.

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

California

PASADENA — Samuel Storrow has awarded the contract for the construction of a 2-story, 85x140-ft. factory for the manufacture of bricks, on Raymond Ave., near Dayton St., to L. P. Pomeroy, 751 North Catalina St., at $38,615.

Connecticut

MERIDEN—The International Silver Co., 48 State St., has awarded the contract for the construction of two 1-story additions to present manufacturing plant on George St., to the Immick Co., State St. Estimated cost, $40,000.

Illinois

CHICAGO—The Advance Spring & Wire Co., 1749 Carroll Ave., plans to construct a 2-story annex to the present plant on the southwest corner of Carroll Ave. and North Wood St. Estimated cost, $125,000.

CHICAGO—The American Glue Co., 123 West Kinzie St., plans to construct a factory at 3640 Iron St. Estimated cost, $160,000. S. Scott Joy, archt.

CHICAGO—The Boyle Ice Co., 136 West Lake St., is building an artificial ice plant on Larrabee St. near Chicago Ave. Estimated cost, $200,000.

CHICAGO—The Troco Nut Butter Co., 30 North Michigan St., is constructing a building for the manufacture of food products, on the southwest corner of 37th and Iron Sts. Caleb E. Johnson, pres.

CHICAGO—The Western Campbell Ice Machine Co. plans to build a plant for the manufacture of ice machinery on Cornelia St. near the Chicago, Milwaukee & St. Paul Ry. Estimated cost, $150,000.

Iowa

DEXTER—The city has awarded the contract for the construction of a sewage disposal plant, to F. H. Christenson, Guthrie Center, at $12,465. Noted Feb. 18.

STANTON—The city has awarded the contract for the construction of a sewage disposal plant, to Harness Bros., Ottumwa, at $12,600. Noted Feb. 25.

TABOR—The city has awarded the contract for the construction of a sewage disposal plant to Ward & Weighton, Davidson Bldg., Sioux City, at $17,560.

Maryland

BALTIMORE—The Autogenous Welding & Machine Co., 1213-1223 Maryland Ave., has awarded the contract for the construction of a 1-story, 25x150-ft. addition to welding plant at 1223 Maryland Ave., to F. A. Condon, 1520 West Baltimore St. Estimated cost, $12,000.

BALTIMORE—The Emery Steel Castings Co., 210 Garrison Lane, has purchased the Pabst Brewery property on South Charles St. at the intersection of Hanover St. and the Baltimore & Ohio R.R. and plans to move its plant and equipment there. Alterations are being made to turn brewery buildings into a modern steel foundry. An electrical steel furnace will be installed in same.

ELKTON—The Bd. of Comrs. is having plans prepared for the construction of a filtration plant, etc. Estimated cost, $40,000. W. H. Mackall, pres. L. J. Houston, Fredericksburg, engr.

Massachusetts

NATICK—The New England Pressed Steel Co. plans to construct a 1-story, 55x85-ft. manufacturing plant addition. Estimated cost, $25,000.

Minnesota

MINNEAPOLIS—The Henepin Atomixed Fuel Co., 520 Security Bldg., is having plans prepared for the construction of a 1- and 2-story, 100x150-ft. fuel-crushing plant on B'way and Johnson St., N. E. Estimated cost, $150,000.

MINNEAPOLIS—W. T. Rawleigh Co., Freeport, Ill., has awarded the contract for the construction of a 2-story, 50x160-ft. medicine factory on 10th Ave. N., and 3rd St., to the C. W. Lundquist Co., 1621 East Hennepin Ave. Estimated cost, $60,000.

Missouri

ST. JOSEPH—The St. Joseph Oil Co., southwest corner 4th and Duncan Sts., is having plans prepared for the construction of a 2-story fuel oil plant. Estimated cost, $200,000.

New Jersey

TRENTON—The Lenox Inc., Mead St., has awarded the contract for the construction of a 1-story, 100x394-ft., 2-story, 20x400-ft., and 3-story, 41x75-ft. buildings for the manufacture of ceramic ware, to Karno-Smith Co., Broad St. Bank Bldg. Estimated cost, $200,000.

TRENTON—The Pocono Rubber Cloth Co., East State St., plans to construct a 1-story factory. Estimated cost, $50,000. Karno-Smith Co., Broad St. Bank Bldg., engrs.

New York

BUFFALO—The Stron Steel Fdry. Co., Norris St., plans to build two 1-story additions to present factory at 33 Norris St. Estimated cost, $20,000.

ITHACA—The Cornell University Bldg. Committee had plans prepared for the construction of a 5-story chemical laboratory on the site of the home of President Jacob Gould Schurman on East Ave. Chemical equipment will be installed in same. Estimated cost, $1,500,000. Gibb & Waltz, Trust Co. Bldg., archts.

Ohio

CLEVELAND—Allen Osborn Co., archt. and engr. Rose Bldg., will soon award the contract for the construction of a 1-story, 100x200-ft. foundry on Dunham Rd., for the Minerva Engine Co., East 66th St. and Euclid Ave. Estimated cost, $60,000. C. S. Goby, pres. and treas.

ASHLAND—The city received bids for furnishing and installing filter equipment from the Amer. Water Softener Co., 1011 Chestnut St., Philadelphia, Pa., $34,000. Noted March 10.

CLEVELAND—The Collinwood Fdry. Co., 17004 Waterloo Rd., has awarded the contract for rebuilding the 1-story, 60x200-ft. foundry which was recently destroyed by fire, to A. A. Lane Constr. Co., Union Bldg. Estimated cost, $50,000.

Oklahoma

PAWHUSKA—The city had plans prepared for the construction of a filtration plant near the present water plant. The plant will have a capacity of 2,000,000 gal. per day. Estimated cost, $65,000. State Water Engr., Oklahoma City, engr.

Oregon

BEND—The Bend Water, Light & Power Co. plans to install an auxiliary pumping and sterilization plant including one 1,500-gal. per minute pump and construct a 30,000-gal. reservoir. Estimated cost, $12,000.

Pennsylvania

PHILADELPHIA—The Brown Instrument Co., Wayne and Windrim Sts., is constructing two buildings, one for the manufacture of recording thermometers and the other for a research department. Estimated cost, $100,000. R. P. Brown, pres.

PHILADELPHIA—The Dept. of Pub. Wks., City Hall, will soon award the contract for the construction of an intake house and for furnishing, delivering and installing various safety devices, including screens, etc., for the Bureau of Water Supply, 788 City Hall, at the Queens Lane Filters and at six other pumping stations.

Tennessee

MEMPHIS—The Fischer Lime & Cement Co., 269 Walnut St., is building a 2-story, 84x300-ft. warehouse on Walnut St. and Linden Ave. W. W. Fischer, pres.

MEMPHIS—The Southern Art Corp. has purchased a 6-acre site at the corner of Nelson St. and East Parkway and plans to construct a plant for the manufacture of art novelties on same. Estimated cost, $220,000. A. C. Jahl, vice-pres.

MEMPHIS—Swift & Co., 35 Union Ave., plans to construct an oil refinery and lard compound plant to have a capacity of 1,000,000 lb. per week. S. L. Kopald, mgr.

Texas

RANGER—The Thurber Earthen Products Co. is building a large rock crushing plant just east of here on the Hagerman land along the Texas & Pacific R.R.

DALLAS—The Fleischman Co., manufacturer of yeast, 711-13 North Ervay St., has purchased a site here and is having plans prepared for the construction of the first unit of a factory on same. Estimated cost, $1,000,000, ultimate cost, $1,500,000. Address G. W. Neary, 4630 Munger Ave.

Washington

SPOKANE—John G. F. Hieber, 2011 1st Ave., is having plans prepared for the construction of a 3-story, 73x160-ft. fruit juice plant. Sterilization coils, cooling coils, etc., will be installed in same. Estimated cost, $100,000. H. E. Smith, 1211 Old Natl. Bank Bldg., engr.

Wisconsin

CUDAHY—The Federal Rubber Co. will build a 6-story, 160x220-ft. factory on Packard Ave. Work will be done by day labor.

MARKESAN—E. W. Laper, village clk., will soon award the contract for the construction of sewage disposal plants, etc. Address G. C. Hank, 465 Sidney St., Madison.

British Columbia

NEW WESTMINISTER—The Imperial Oil Co., Cambie and Smith Sts., Vancouver, has awarded the contract for the construction of a distributing plant, etc., to the Dominion Constr. Co., 509 Richards St., Vancouver, at $24,500.

Ontario

DES QUINZE—M. J. O'Brien, Renfrew, plans to construct a pulp and paper plant, etc., here. Estimated cost, $4,000,000.

LONDON—The Bd. Educ., City Hall, is having plans prepared for the construction of a collegiate building on Ridout St. Chemical and physical laboratory equipment will be installed in same. Estimated cost, $215,000. L. V. Carrothers, Hydro Offices, archt.

TULBURY—The Tulbury Brick & Tile Co., Ltd., manufacturer of all sizes of drain tile and red wire cut face brick, is in the market for Bensing automatic brick cutters, 9-in. capacity and drain tile cutters, 13½-in. capacity, etc.

Quebec

IBERVILLE — The town has been ordered by the Provincial Bd. of Health to construct a filtration plant and improve waterworks system. Estimated cost, $25,000.

LEVIS—The town has been ordered by the Provincial Bd. of Health to construct a filtration plant and improve waterworks system. Estimated cost, $25,000.

SOREL—The town has been ordered by the Provincial Bd. of Health to construct a filtration plant and improve waterworks system. Estimated cost, $25,000.

Coming Meetings and Events

THE AMERICAN ASSOCIATION OF ENGINEERS will hold its fifth annual convention at the Planters Hotel in St. Louis, May 10 and 11.

THE AMERICAN CHEMICAL SOCIETY will hold its annual meeting April 13 to 16 inclusive at St. Louis. Headquarters will be at the Hotel Statler.

THE AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting in Boston, April 8, 9 and 10. Headquarters will be at the Copley-Plaza Hotel.

THE AMERICAN ELECTROPLATERS' SOCIETY will hold its eighth annual convention in Rochester, June 30 to July 3. Headquarters will be at the Seneca Hotel.

THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its semi-annual meet-

ing in Montreal, June 21 and 22; Ottawa, June 23; Shawinigan, June 24 and 25, and La Tuque, June 26.

THE AMERICAN IRON AND STEEL INSTITUTE will hold its spring meeting May 28 at the Hotel Commodore, New York City.

THE AMERICAN SOCIETY FOR TESTING MATERIALS will hold its annual meeting at Asbury Park, N. J., June 22 to 25.

THE AMERICAN ZINC INSTITUTE will hold its spring meeting May 10 and 11 at the Congress Hotel, Chicago, Ill.

THE CHAMBER OF COMMERCE OF THE U. S. announces that its eighth annual meeting will be held at Atlantic City, April 27 to 29, the subject of which will be "Increased Production."

THE CHEMICAL SOCIETY OF THE COLLEGE OF THE CITY OF NEW YORK is pleased to announce the following lectures for the spring semester of 1920 to be delivered in the Doremus Lecture Theater: "Romance of Leather Making," Tuesday, April 13, at 4 P.M., E. A. Brand (*Lantern*); "Water Supply and Drainage in War Cantonments," Wednesday, April 21, at 4 P.M., Prof. D. D. Jackson, administrative head, department of chemical engineering, Columbia University (*Lantern*); "Modern Coke and Gas Manufacture" (KOPPERS Process), Thursday, April 29, at 4 P.M., E. L. Crowe (*Lantern and cinema*); "Chemical Naval Warfare," Friday, May 7, at 4 P.M., Prof. James Kendall, professor of chemistry at Columbia University; "Fighting Fire—Firefoam," Friday, May 14, at 4 P.M., F. A. Epps, chief engineer, the Foamite Firefoam Co. (*Experimental, cinema and lantern*.)

THE ELECTRIC FURNACE ASSOCIATION will hold a meeting in Boston, April 8 to 10, together with the American Institute of Electrical Engineers and the American Electrochemical Society. The subject is "Electrically Produced Alloys and Power for Electrochemical Purposes." Headquarters will be at the Copley-Plaza Hotel.

THE INSTITUTE OF METALS DIVISION OF THE A.I.M.E. will hold its usual joint meeting with the American Foundrymen's Association at Columbus, Ohio, during the week beginning Oct. 4.

THE INTERNATIONAL MINING CONVENTION will be held in Seattle April 7 to 10.

THE IRON AND STEEL INSTITUTE (London) will hold its annual meeting May 6 and 7, 1920, at the House of the Institute of Civil Engineers, Great George St., London, S. W. 1. The retiring president, Eugene Schneider, will induct into the chair Dr. J. E. Stead, the president-elect.

THE MINE INSPECTORS' INSTITUTE OF AMERICA will hold a meeting at Cleveland, Ohio, July 13.

THE MINING SOCIETY OF NOVA SCOTIA has planned a meeting for May 4 and 5 which will be held in Glace Bay.

THE SIXTH NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES will be held in the Grand Central Palace, New York City, Sept. 20 to 25.

THE NATIONAL FERTILIZER ASSOCIATION will hold its twenty-seventh annual convention at the Greenbrier, White Sulphur Springs, W. Va., the week of June 21.

THE NATIONAL FOREIGN TRADE CONVENTION will be held in San Francisco, May 12 to 15. Chinese delegates have chartered the S. S. Ecuador for transportation to this conference.

THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its spring meeting at the Hotel Waldorf and the Hotel Astor, New York City, April 12 to 16.

Industrial Notes

THE EAGLE-PICHER LEAD CO., Chicago, Ill., at the annual meeting held in Cincinnati on Feb. 17, elected Dr. John A. Schaeffer vice-president of the company in conjunction with his former position as chief chemist and chief metallurgist. His headquarters will be in the Railway Exchange Bldg., St. Louis. R. E. McCormack, formerly of Joplin, Mo., will be his assistant.

TECHNICAL ADVERTISING SERVICE, INC., 1133 Broadway, New York City, has recently enlarged its technical staff and opened an export service division under the management of J. S. Beckett, a chemical engineer of wide experience in laboratory, plant and construction work. This service offers to exporters answers to such inquiries as "Please send me a complete equipment for a metallurgical laboratory 12 x 17 ft. sq." or "a plant to make rubber heels," and is equipped to take care of any inquiry in the technical field, covering **mechanical**, chemical, civil, mining and metallurgical

engineering. This department draws up complete and detailed specifications for all equipment covered by the inquiry, obtains quotations from the manufacturers, places the order and follows it through until the material is delivered as specified and on time at the dock or alongside the steamer.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., announces the appointment of Arthur Elliott Allen as district manager at New York, to succeed Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Co.

H. DEVERELL announces that he has sold his interest in and severed his connection with Deverell, Spencer & Co. He will be engaged hereafter in the elevating, conveying and transmission machinery business, with offices at 1401 Lexington Bldg., Baltimore, Md.

THE CHEMICAL EQUIPMENT CO., Chicago, is moving to a new and larger plant at 2457-59 South Western Ave. The general officers will remain at 910 Monadnock Bldg.

THE BUFFALO FORGE CO., Buffalo, N. Y., at a recent meeting elected the following new officers: Henry W. Wendt, president; Edgar F. Wendt, vice-president and treasurer; Henry W. Wendt, Jr., vice-president and secretary; C. A. Booth, vice-president and sales manager. The new directors include the above-named officers, and in addition H. W. Whiting.

GLANDER & Co., formerly at 115 Broadway, New York City, are now located at 568 Broad St., Newark, N. J.

DEVERELL, SPENCER & Co., Baltimore, Md., announce that John C. Carter has purchased H. Deverell's interest in the company, and will be actively associated with J. H. Spencer. The name of the company will shortly be changed to the Spencer Construction Co.

THE GENERAL NAVAL STORES Co., with general offices at 90 West St., New York, has recently made a material expansion of the facilities in Chicago, to handle the pressure of business at that point. Enlargements trebling the office space in the McCormick Bldg. and increasing the warehouse and yardage space at 37th Street and Normal Ave. from 10,000 to 25,000 sq.ft. and installing storage tanks are now in process. Yardage expansion will give railroad trackage, which the company has not previously enjoyed. This company is the exclusive agent for the output of the Newport Co., a large producer of pine tar products, with works at Bay Minette, Ala., and Pensacola, Fla. It also has an office in St. Louis, Mo., and maintains stocks in Cincinnati, Detroit, Philadelphia, Norfolk and Denver.

THE ELECTRIC FURNACE CO., Alliance, Ohio, has opened a Middle Western office at 301 Frisco Bldg., St. Louis, Mo., in charge of W. E. Prosser.

THE TULSA LABORATORIES, formerly owned by James H. Holden, have been taken over by H. R. Rowe, W. A. Goldstrap and Roy L. Ginter. The new owners are putting in new supplies and equipment and are prepared to make oil field tests on casinghead and natural gas, also efficiency tests on gasoline plants where boiler trouble is experienced. In the laboratory they will handle oil and general analytical work, including complete gas analysis and drug assays.

THE AMERICAN STEAM CONVEYOR CORP., Chicago, announces that arrangements have been made with the Wellman Bibby Co., Ltd., 38 Kingsway, London, W. C., 2, England, to act as its representative in Great Britain and Ireland for the sale of the American steam ash conveyor. It is the intention of the Wellman Bibby Co. to manufacture the American steam ash conveyor in England.

THE JEFFREY MFG. Co., Columbus, Ohio, has opened a new branch office in Los Angeles, Cal., in charge of F. R. Field, formerly manager of the Denver office. This addition to branch offices has been made necessary to give adequate service to clients in California, Arizona, Nevada and the State of Sonora, Mexico.

THE ROME WIRE CO., Rome, N. Y., has recently authorized an increase in the capital stock to $4,000,000 of 7 per cent first preferred and $5,650,000 common. The shares in each issue are $100 par value. The company's main plant is located at Rome, N. Y., on the New York Central R.R., and on the New York State Barge Canal. The land comprises twenty-two acres with 348,000 sq.ft. of modern factory buildings, fully protected by sprinkler equipment. All of the buildings have been constructed since 1905 and the larger part of them since 1914. The equipment is all modern and first class in every particular. The Buffalo plant consists of eleven acres of land in the northeastern part of the

city, on the D., L. & W. R.R., with excellent trackage facilities and well-constructed buildings adapted to the manufacture of electrical wires and cables. A large addition is under construction at this branch.

THE AMERICAN ASSOCIATION OF COMMERCE AND TRADE IN BERLIN (American Chamber of Commerce) has just begun the monthly publication of the *Transatlantic Trade* in the interests of the American manufacturer, exporter and importer. The first issue is a 32-page magazine containing reports of commercial and industrial conditions in Germany, and opportunities for American goods in that country. Names of firms open for commercial connection with American manufacturers and other items of commercial interest are given. The subscription price in the United States is $2 per year.

THE WESTINGHOUSE ELECTRIC & MFG. Co., Pittsburgh, Pa., has given an insurance policy for $500 without cost to each employee who has been in the company service for six months or more. After April 1 employees may increase the value of their policies to amounts varying from $1,000 to $2,000 depending upon their length of service and continuity of saving. All employees who have been in the company's service for six months or longer and who deposit a sum each payday in the employees' savings fund equal to 2 per cent or more of their earnings will not only receive 4½ per cent interest compounded semi-annually on such deposits but in addition will automatically have their insurance increased to amounts up to $2,000 depending on the length of time they have been with the company. This insurance is to be made effective at all of the various offices and plants of the Westinghouse Electric Co. and will affect approximately 50,000 persons.

THE MOTOR TRUCK OWNERS OF NORTH AMERICA is a new organization of motor truck users and operators formed at the recent automobile shows in New York, Chicago and other cities. It is an outgrowth of the tri-state association which included Indiana, Ohio and Pennsylvania. Indianapolis, Ind., is the new headquarters.

THE GLIDDEN STORES of Cleveland, Ohio, will open a branch at 157 Madison Ave., Memphis, Tenn., for the sale of varnishes, insecticides and sundry products. B. F. Hammond has been appointed district manager.

THE TOLEDO SCALE CO. has established a branch sales office at 11 South Third St., Memphis, Tenn., under the direction of W. D. Weidlein.

Manufacturers' Catalogs

THE QUIGLEY FURNACE SPECIALTIES Co., New York, has issued a folder on low-cost per heat-hour of pots (cyanide chloride, lead) and boxes (carbonizing annealing).

THE JOSEPH DIXON CRUCIBLE Co., Jersey City, is distributing, to any foundryman requesting it, a copy of booklet No. 190-A, entitled "Crucibles—Their Care and Use." This company has found that many foundrymen do not fully appreciate the importance of keeping and handling their crucibles in a manner which will insure the greatest number of heats with the least danger of accidents, and this booklet is being distributed to emphasize this point.

THE DENVER FIRE CLAY Co., Denver, Col., announces a new catalog on D.F.C. Clay Products. This attractive booklet gives in 20 pages descriptions and illustrations of such products as annealing cups, assay crucibles, annealing cup trays, tall form crucibles, crucible covers, melting crucibles, special crucibles, crucibles for melting platinum, etc., together with prices.

THE HIRES TURNER GLASS Co., Philadelphia, Pa.: Bulletin No. 11-A, entitled "Corrugated Wire Glass for Industrial Buildings," illustrates and describes the different types of corrugated wire glass and the purposes to which they can be put. Photographs of actual installations are shown.

THE GRISCOM-RUSSELL Co., New York City, is issuing Bull. 311, on the Reilly Evaporator, submerged type. Illustrations are given of the evaporator closed and open, with a steel shell, single manifold, and also with a cast-iron shell, double manifold, together with a description; together with instructions for marine installation of a multicoil evaporator and distiller plant.

THE VINELAND SCIENTIFIC GLASS Co., Vineland, N. J., is issuing a "loose-leaf" compilation of illustrated price lists of items of chemical, medical, pharmaceutical, and surgical glassware.